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ABSTRACT

These hearings consist of testimony by and the prepared statement of George A. Keyworth II (science advisor to President Reagan and director of the Office of Science and Technology Policy) on the Reagan administration's overall science policy in the proposed research and development (R&D) budget for fiscal year 1985. A major focus is on the administration's three goals for science policy: (1) the development of the highest quality technical talent that can be produced; (2) the continuing pursuit of excellence in whatever research is chosen; and (3) the expansion and strengthening of partnerships between government, industry, and universities for the purpose of bringing the benefits of new knowledge and advanced technology to the United States. Among the areas considered are an assessment of the cumulative impact of R&D policy during the Reagan administration's first 3 years (considering federal R&D obligations, basic research obligations, and basic research obligations to universities and colleges) and highlights of the Reagan administration's FY 1985 budget (examining the National Science Foundation's Presidential Young Investigator Awards, a proposed program in universities to integrate both research and teaching needs for engineering, and a program focusing on supercomputers). (JN)

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1984 SCIENCE AND TECHNOLOGY POSTURE HEARING WITH THE DIRECTOR OF THE OFFICE OF SCIENCE AND TECHNOLOGY POLICY

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HEARING

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

NINETY-EIGHTH CONGRESS

SECOND SESSION

FEBRUARY 1, 1984

[No. 134]

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1984 SCIENCE AND TECHNOLOGY POSTURE HEARING WITH THE DIRECTOR OF THE OFFICE OF SCIENCE AND TECHNOLOGY POLICY

WEDNESDAY, FEBRUARY 1, 1984

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The committee met, pursuant to call, at 10:30 a.m., in room 2318, Rayburn House Office Building, Hon. Don Fuqua (chairman of the committee) presiding.

The CHAIRMAN. The committee will be in order.

Without objection, permission to be—will be granted for taking photographs and television coverage and recordings of the hearing, and prior to that, the members have before them—resolution has been passed out commemorating the 25th anniversary of the Committee on Science and Technology, and I would like to move that the committee adopt the committee resolution placed before the members.

[The resolution follows:]

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COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

Resolution

To celebrate the twenty-fifth anniversary of the founding of the Committee on Science and Technology.

Whereas, 1984 marks the twenty-fifth anniversary of the founding of the Committee on Science and Technology;

Whereas, the Committee on Science and Technology was established to fulfill a Congresional resolve and determination to achieve American preeminence in science and space.

Whereas, the jurisdiction of the Committee on Science and Technology has expanded to include research and development for energy, environment, and civil aviation and science policy; and

Whereas, the Committee on Science and Technology has been steadfastly guided by the able leadership and vision of four distinguished Chairmen, namely, Overton Brooks of Louisiana, George P. Miller of California, Olin E. Teague of Texas, and Don Fuqua of Florida.

Whereas, the accomplishments of the Committee on Science and Technology reflect the dedication and distinguished service of many Members of both parties of the House of Representatives;

Whereas, the Committee on Science and Technology continues its work for the expansion of scientific knowledge and its application to the benefit of mankind by fostering communication and cooperation among scientists, engineers, educators, industrialists, elected representatives and the general public.

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Therefore, be it resolved, that the Committee on Science and Technology commemorate the occasion of the twenty-fifth anniversary of its founding; and

Resolved, that the Chairman of the Committee on Science and Technology effectuate this commemoration by such celebrations as are appropriate to the occasion;

Resolved, that the Clerk communicate a copy of this resolution to all Members, both present and former, of the Committee on Science and Technology.

CHAIRMAN
Committee on Science and Technology
U.S. House of Representatives

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The CHAIRMAN. If there is no objection, the resolution is agreed to.

Who was supposed to place the resolution out? Here it is. OK.

With the submission today of the President's budget proposal for fiscal year 1985, the Committee on Science and Technology begins its review of the R&D portion of that budget. As has been our practice in recent years, we start with that review with our annual posture hearings.

The purpose of this hearing is to provide the committee with an overview of the administration's Science and Technology Policy so that we can place the individual Agency and program recommendations in a broader perspective for those policies.

It is our understanding that the budget proposals do include a further strengthening of the Federal Government's support for basic research. This would continue the policy of supporting basic research, which was begun 3 years ago, and which has had the support of this committee.

Similarly, in the field of space exploration, the President has announced his commitment to the establishment of a permanent space station, a decision which promises to reestablish America's unquestioned leadership in the exploration of this new frontier.

This Committee has long supported a strong space program for the Nation, and while we want to examine the details of the proposal, I believe that we can all applaud this initiative.

I'm sure that there will be other areas that we may have some different priorities, but I do appreciate the cordial working relationship that we have had with the Office of Science and Technology Policy. Again this year, we wish to welcome and to present the administration's statement, Dr. George Keyworth, the Science Advisor to the President and the Director of the Office of Science and Technology Policy in the White House.

Dr. Keyworth has been a very able Director of OSTP and we look forward to your testimony, and at this time, I would like to recognize the ranking minority member of the committee, Mr. Winn, for any comments that he wishes to make.

Mr. WINN. Thank you, Mr. Chairman, for the opportunity to welcome Dr. Keyworth, Director of the Office of Science and Technology Policy. We look forward to his review of the administration's proposed fiscal year 1985 science budget. The preliminary information that we have on this proposed budget indicates a substantial increase over the 1984 funding level.

Mr. Chairman, the Science and Technology Committee has always provided strong support for basic and fundamental research. Therefore, we can certainly concur in the administration's continued increase for that broad program. We recognize the need for a strong science program as the foundation of long-term industrial growth and national security. It is only through continual emphasis on basic research that we will maintain strength in our international economic and scientific positions.

In addition to this consideration of research along general lines, we expect to hear of directed programs involving man in space, acid deposition, and science and engineering education.

FEBRUARY 10, 1984

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During the past 18 months, at least three reports have been issued which were totally or partially addressed to our national laboratories. One was prepared by a DOE-sponsored Energy Research Advisory Board; another was requested by OSTP, the so-called Packard Report, and the third that I have in mind was recently released by the White House and is known as the Grace Report.

Our national laboratories represent a huge investment by the Federal Government in both facilities and manpower. DOE places a value on the laboratories within the Department at $8 billion in physical assets alone. Possibly OSTP can give us some idea of the administration's response to all those reports. As we all know, there were several areas of agreement among them.

In view of the time, the effort, and the intelligence which has gone into those reports, I would consider it rather wasteful if we paid no more attention to their contents. I've been advised that OSTP has requested the National Academy of Sciences to review the material sciences research programs. It appears that the request was for evaluation of all federally funded programs.

In view of the fact that DOE alone funds materials research to nearly $400 million annually, we're considering vast sums of money. I know of no centralized oversight for expenditure of such funds on materials research. I'm unaware of any substantial participation by industry in any of this activity.

So, I hope that this brief account can be expanded by OSTP, and again, Dr. Keyworth, we're glad to have you here today. We look forward to your testimony.

Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Lujan.

Mr. LUJAN. Yes, thank you, Mr. Chairman. I have a short opening statement. I want to welcome Jay Keyworth, of course, he is a former constituent of mine, he comes from Los Alamos, and I used to represent that area until redistricting took care of it, but we still feel very much—much a part of it. But basically why I did want to make some opening statements is to congratulate you for your strong role in reexamining the Government's role in research and development, Jay.

You have emphasized the importance of federally supported basic research and made clear this should be the top priority in the Federal R&D budget, but you've also helped to point out that the Federal Government should allow our partners, and that's the private sector, to take a strong role in the later phases of technology.

Too often in the past, we've been seduced by the myth that if the Government doesn't do it, that it won't happen, while quite the opposite may be close to the truth, since no national investor would want to be in the position of competing with the—with the Government, so your policy of emphasizing Federal support of basic R&D and your policy of encouraging partnership of the Federal Government with industry is the—is the right approach.

I believe this country is becoming more aware of the fact that our national strength is in innovation and that our future economy will continue to be built on technology development. The Govern-

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ment's role should be to enable things to happen, but the Government's role is not to make things happen.

Once again, I want to recognize your own role in reexamining that role of the Government in research and development and I look forward to your testimony this morning and thank you and welcome once again.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. Lujan.

Do any other members wish to submit statements? If not, Dr. Keyworth, we're very pleased to welcome you again to our committee and I understand you have a longer prepared statement which, without objection, we'll make part of the record, and then, if you desire to summarize, we'd be delighted to hear from you.

STATEMENT OF DR. GEORGE A. KEYWORTH II, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT, THE WHITE HOUSE, WASHINGTON, DC

Dr. KEYWORTH. Thank you very much, Chairman Fuqua, and members of the subcommittee. First, if I may, I would like to introduce the new deputy and assistant directors in our office, since we have had a substantial number of new additions that I believe very much strengthen our office.

Briefly, our new Deputy Director is Dr. John McTegue; our next Assistant Director for General Science is Dr. Ralph DeVries; for Space Science and Technology is Dr. Richard Johnson; for Energy, Natural Resources and International Affairs is Mr. Wallace Kornack; for Institutional Relations and acting for Life Sciences is James Ling; and Assistant Director for Defense Technology and Systems is Dr. Maurice Roesch.

Now I would like to proceed with my abbreviated, prepared comments, Mr. Chairman. This is my third opportunity to meet with this committee to discuss the administration's overall science policy. I hope my presentation and our discussion today will make two things clear: One is our consistency in applying those basic principles of science policy that were enunciated at the start of the administration; the other is our continuing success, the administration's and the Congress', in strengthening American science and technology to respond to the rapidly changing world in which we live.

In discussing the administration's science policy in the proposed fiscal year 1985 R&D budget today, I want to emphasize those same three principles that have underlain our programs all along. Our three goals for science policy are these: first, the development of the highest quality technical talent we can produce; second, the continuing pursuit of excellence in whatever research we choose to do; and third, the expansion and strengthening of partnerships between Government, industry and universities for the purpose of bringing the benefits of new knowledge and advanced technology to our Nation.

Mr. Chairman, this year's budget is the fourth one that the Reagan administration has prepared from scratch and sent to Congress. As you'll see, we're presenting a strong program of research

and development for the coming year, one that continues to strengthen the nation's capacity to conduct R&D and to train new scientists and engineers, and one that permits important new projects to start.

But before we discuss how our fiscal year 1985 programs meet those objectives, I want to take a few minutes to assess the cumulative impact of R&D policy during the Reagan administration's first 4 years. With your permission, I'd like to refer to the three charts that are attached as the last pages of my prepared text. All these charts refer to nondefense R&D, which is the area of the budget that I want to concentrate on today.

The first chart I'll refer to is titled "Federal R&D Obligations." Over these 4 years, the administration's science policy has been committed to an emphasis on basic research for the reasons I've just described and a concomittant reduction of Government support for demonstration, development, and applied research, projects that are more appropriate for the private sector.

In particular, we made substantial reductions in energy-related demonstration projects and I believe this is a reflection of both common sense and economic reality. So when we look at the three categories of Federal funding in nondefense areas: basic research, applied research, and development, we see a startling shift in relative priorities during this administration.

Please note that this and the other charts show constant 1983 dollars, which means the curves have been corrected for inflation and represent actual purchasing power.

You can see how basic research has gone from the smallest fraction of that nondefense R&D to the largest; at the same time, development funding has dropped by nearly 50 percent.

To see more specifically how that Federal support for basic research has grown, we turn to the chart titled "Basic Research Obligations." It shows basic research for the five largest R&D funding agencies since 1978, and again, in constant dollars. As you can see, all five agencies have had strong and consistent growth, and in four of those cases, that growth follows level or even declining real budgets in the 5 years before.

Finally, on the chart titled "Basic Research Obligations to Universities and Colleges," we can see the growth in basic research funds that have gone specifically to universities and colleges. Here the result of the science, policy is even more pronounced.

Although it's not shown, we could trace a consistent decline in basic research funding for universities back to 1968, and where the chart picks up, we see that there was essentially no growth from 1979 to 1981. However, from 1981 to the level being proposed for 1985, this support for universities rose by 26 percent, and again, in real terms.

Moreover, the true impacts of Federal funding on universities are even greater because so much university research draws on Federal investment in unique, centralized facilities. Substantial amounts of the funding that goes to Federal and national labs actually support university research in phsyics, astronomy, material science, and space sciences.

So I want to stress that these graphs and numbers reflect a point I've been making for as long as I've been in Washington, that

during this period, we've been seeing the strongest support for basic research in 20 years.

Now, with that as prelude, let me briefly discuss some of the highlights of the President's proposed fiscal year 1985 R&D budget. Detailed information appears in the actual budget documents being submitted to the Congress today, so I won't try to be comprehensive in my coverage.

Today, Federal R&D, the total of R&D obligations, will increase in 1985 to $53 billion. Over the 4 years of the Reagan administration, Federal funds for R&D have increased by 52 percent, with this year's increase being 14 percent. The largest increase in 1985 will go for defense R&D, which increases 22 percent, and will support continuing defense modernization.

We're still in the position of having to pay special attention to these defense modernization needs to compensate for inadequate funding during the previous decade.

Basic research is targeted for the next largest increase, 10 percent, and will rise to $7.9 billion in 1985. Since 1981, Federal support for basic research has increased by 55 percent, a growth of nearly $3 billion. Half of that support goes directly to universities, and as I said, a good bit more is destined to make possible faculty research in Federal facilities.

As in previous years, you'll find we're applying those basic research increases selectively to areas of strong opportunity and excitement. Although not readily identified in the budget information, we continue to give high priority to project support for university research through agencies like NSF, NIH, DOE, DOD, and NASA.

This kind of support is the most important element of the budget in continuing on the path to restoring the health and vitality of our Nation's universities.

Mr. Chairman, my prepared testimony details several specific initiatives for fiscal year 1985, but in the interest of time, I'll confine the rest of my summary to two specific issues raised by the committee. The first deals with the development, acquisition, and availability for the research community of supercomputers.

I believe we all agree that it's imperative for our academic research community, faculty, and students, to have opportunities to work with state-of-the-art computing tools.

Let me suggest three main reasons for this importance. One is the direct benefit to frontier research. Supercomputers offer the best known way to attack many large-scale science and engineering problems, a way to model complex physical interactions. Second is the opportunity for young scientists and engineers to learn what supercomputers can do and to become familiar with them. After all, these people are the ones who will be developing the supercomputers' potential for solving new kinds of problems in the future.

Third is the vital contributions that the research community will make to designing and developing the software to make the supercomputers even more useful in the research process.

Mr. Chairman, I covered these and other topics in testimony submitted to this committee last November 16, so I won't take up your time by going over those issues again. However, I know of the com-

mittee's strong interest in this topic, so I do want to briefly outline some specific efforts being proposed for fiscal year 1985.

NSF and DOE plan to provide increased access for university researchers to supercomputers, both by allocating greater amounts of time on supercomputers at national labs, such as through DOE's magnetic fusion energy computing network, and by installation of new supercomputing facilities dedicated to academic users.

NSF will also be installing a class VII supercomputer at the National Center for Atmospheric Research for use by the atmospheric and ocean sciences community.

In parallel efforts, DOE, NSF, and DOD will fund increased research in various areas of computer science and electronics that will be applicable to future generations of supercomputers. We're confident that these varied activities, in conjunction with continued purchase of the most advanced supercomputers for direct Government use, will in turn provide the market incentives to permit U.S. commercial manufacturers to maintain their technological leadership in this field.

Mr. Chairman, I'd also like to bring you up to date on the progress being made on implementing the recommendations of the White House Science Counsel's Review of Federal Laboratories. As you know, this review was done under the leadership of David Packard and resulted in a series of recommendations that were presented to the President last July.

Following that presentation, the President instructed OSTP and OMB to lead an interagency effort to work on ways to implement the recommendations in the panel's report, and he directed the heads of Federal departments and agencies to work with us in doing that.

The Packard panel, after more than 1 year of study of the Federal labs, concluded that the Nation could be deriving far more benefit from these valuable R&D resources, and they recommended changes in five major areas to help improve their effectiveness. Without going into detail, I would just indicate that the recommendations called for clearer missions for the labs, for changes in the personnel systems to attract and retain technical talent, for more stable funding, and more autonomy for the labs themselves in managing their research, and for broader interactions between the labs and other public- and private-sector R&D organizations.

Over the past half year, an interagency committee has been making good progress in developing approaches to carry out these recommendations. They've done this by working with lab and agency officials, with potential users of lab results, and with the original White House Science Counsel panel. In this regard, I want to specifically acknowledge the tremendous contribution that David Packard has made and continues to make in this effort.

Some of the recommendations, such as those encouraging greater interaction with industry and universities, can be implemented directly by the actions of the labs and parent agencies. Other recommendations, such as those calling for changes in Federal personnel regulations, will require legislation.

As specific proposals begin to take shape, the individual agencies, as well as my office, will discuss them with the congressional bodies that have oversight responsibilities in this areas. We hope

that the bulk of this work will be completed by the time we report back to the President July 1, 1984, though we all recognize that optimizing the return on our massive investment in Federal labs—and I remind you, about one-third of the total R&D budget, or nearly $17 billion in fiscal year 1985 is spent there—demands continual attention to the Nation's R&D climate and demands readiness to change as the times change.

Mr Chairman, this concludes my presentation and I would be pleased to respond to questions at this time.

[The prepared statement of Dr. Keyworth follows:]

PROPOSED TESTIMONY OF DR. G. A. KEYWORTH, II
SCIENCE ADVISOR TO THE PRESIDENT AND
DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY
EXECUTIVE OFFICE OF THE PRESIDENT

TO THE COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

HEARINGS ON SCIENCE POLICY AND
THE PRESIDENT'S FISCAL YEAR 1985 BUDGET FOR
RESEARCH AND DEVELOPMENT

FEBRUARY 1, 1984

Chairman Fuqua and Members of the Subcommittee:

This is my third opportunity to meet with this Committee to discuss the Administration's overall science policy. I hope my presentation and our discussion today will make two things clear. One is our consistency in applying those basic principles of science policy that were enunciated at the start of the Administration. The other is our continuing success--the Administration's and the Congress's--in strengthening American science and technology to respond to the rapidly changing world in which we live.

By their nature, science and technology demand long-term planning and preparation, starting early in the educational process and extending into the maturing of young researchers and their integration into the research academic, or industrial communities. Major facilities

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MAY TAKE A DECADE TO DEVELOP AND MAY BE USED FOR DECADES MORE. IT'S CLEAR THAT THE PLANNING CYCLES FOR THE WORLD OF SCIENCE AND TECHNOLOGY ARE FAR LONGER THAN THE TURNAROUND TIMES IN THE POLITICAL ARENA. SO THOSE OF US WHO ACCEPT THE RESPONSIBILITY FOR CHARTING THE COURSE FOR GOVERNMENT PROGRAMS IN SCIENCE AND TECHNOLOGY MUST ALSO ACCEPT THE RESPONSIBILITY FOR CLEARLY ARTICULATING--AND STICKING TO--BASIC PRINCIPLES FOR GUIDANCE.

IN DISCUSSING THE ADMINISTRATION'S SCIENCE POLICY AND THE PROPOSED FISCAL YEAR 1985 R&D BUDGET TODAY, I PROPOSE TO FOCUS ON THOSE SAME THREE PRINCIPLES THAT HAVE UNDERLAIN OUR PROGRAMS ALL ALONG. OUR THREE GOALS FOR SCIENCE POLICY ARE THESE: FIRST, THE DEVELOPMENT OF THE HIGHEST QUALITY TECHNICAL TALENT WE CAN PRODUCE; SECOND, THE CONTINUING PURSUIT OF EXCELLENCE IN WHATEVER RESEARCH WE CHOOSE TO DO; AND THIRD, THE EXPANSION AND STRENGTHENING OF PARTNERSHIPS BETWEEN GOVERNMENT, INDUSTRY, AND UNIVERSITIES FOR THE PURPOSE OF BRINGING THE BENEFITS OF NEW KNOWLEDGE AND ADVANCED TECHNOLOGY TO OUR NATION.

THOSE OF YOU WHO HAVE HEARD ME ON THE SUBJECT OF R&D POLICY KNOW HOW STRONGLY WE'VE STRESSED THE IMPORTANCE OF THE FEDERAL GOVERNMENT'S ROLE IN SUPPORT OF BASIC RESEARCH. I'VE EVEN REFERRED TO THAT RESPONSIBILITY

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AS A FEDERAL TRUST. NOT ONLY IS BASIC RESEARCH AN ESSENTIAL INVESTMENT IN THE NATION'S LONG-TERM WELFARE, BUT IT'S LARGELY A FEDERAL RESPONSIBILITY BECAUSE ITS BENEFITS ARE SO BROADLY DISTRIBUTED. QUITE SIMPLY, BASIC RESEARCH IS A VITAL UNDERPINNING FOR OUR NATIONAL WELL-BEING. THERE ARE THREE REASONS FOR THAT.

FIRST, RESEARCH GRANTS TO UNIVERSITIES, WHERE THE MAJORITY OF THE BASIC RESEARCH IS DONE, PERMIT THE TRAINING OF TENS OF THOUSANDS OF GRADUATE STUDENTS UNDER SOME OF THE MOST DEMANDING AND STIMULATING RESEARCH CONDITIONS ANYWHERE. THIS NEW TALENT WILL BE RESPONSIBLE FOR MAINTAINING AMERICAN TECHNOLOGICAL LEADERSHIP IN COMING YEARS.

SECOND, STRONG SUPPORT FOR BASIC RESEARCH PERMITS U.S. SCIENTISTS AND ENGINEERS TO CHALLENGE INTELLECTUAL FRONTIERS IN THE MOST IMPORTANT FIELDS OF SCIENCE AND TECHNOLOGY. THAT PROVIDES THE NEW KNOWLEDGE THAT DRIVES OUR ECONOMIC GROWTH, IMPROVES OUR QUALITY OF LIFE, AND UNDERLIES OUR NATIONAL DEFENSE.

AND THIRD, WELL CHOSEN BASIC RESEARCH PROJECTS STIMULATE PRODUCTIVE PARTNERSHIPS BETWEEN SCIENTISTS AND ENGINEERS IN ALL SECTORS OF SOCIETY--PARTNERSHIPS THAT ARE INCREASINGLY VITAL TO DEVELOPMENT OF NEW TECHNOLOGIES

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THAT WILL KEEP AMERICAN INDUSTRY COMPETITIVE WITH IMPROVING FOREIGN COMPANIES AND WILL SPEED THE APPLICATION OF NEW KNOWLEDGE TO OUR INCREASINGLY TECHNOLOGICAL DEFENSE NEEDS.

THIS YEAR'S BUDGET IS THE FOURTH ONE THAT THE REAGAN ADMINISTRATION HAS PREPARED FROM SCRATCH AND SENT TO CONGRESS. AS YOU'LL SEE, WE'RE PRESENTING A STRONG PROGRAM OF RESEARCH AND DEVELOPMENT FOR THE COMING YEAR, ONE THAT CONTINUES TO STRENGTHEN THE NATION'S CAPACITY TO CONDUCT R&D AND TRAIN NEW SCIENTISTS AND ENGINEERS, AND ONE THAT PERMITS IMPORTANT NEW PROJECTS TO START. BUT BEFORE DISCUSSING HOW OUR FY 1985 PROGRAMS MEET THOSE OBJECTIVES, I WANT TO TAKE A FEW MINUTES TO ASSESS THE CUMULATIVE IMPACT OF R&D POLICY DURING THE REAGAN ADMINISTRATION'S FIRST FOUR YEARS.

WITH YOUR PERMISSION, I'D LIKE TO REFER TO THE THREE CHARTS THAT ARE ARE ATTACHED AS THE LAST PAGES OF MY PREPARED TEXT. ALL THESE CHARTS REFER TO NON-DEFENSE R&D, WHICH IS THE AREA OF THE BUDGET THAT I WANT TO CONCENTRATE ON TODAY.

THE FIRST CHART I'LL REFER TO IS TITLED "FEDERAL R&D OBLIGATIONS." OVER THESE FOUR YEARS THE ADMINISTRATION'S SCIENCE POLICY HAS BEEN COMMITTED TO AN EMPHASIS ON BASIC RESEARCH, FOR THE REASONS I'VE JUST DESCRIBED,

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AND A CONCOMITTANT REDUCTION OF GOVERNMENT SUPPORT FOR DEMONSTRATION, DEVELOPMENT, AND APPLIED RESEARCH PROJECTS THAT ARE MORE APPROPRIATE FOR THE PRIVATE SECTOR. IN PARTICULAR, WE MADE SUBSTANTIAL REDUCTIONS IN ENERGY-RELATED DEMONSTRATION PROJECTS. THIS IS A REFLECTION OF BOTH COMMON SENSE AND ECONOMIC REALITY. SO WHEN WE LOOK AT THE THREE CATEGORIES OF FEDERAL FUNDING IN NON-DEFENSE AREAS--BASIC RESEARCH, APPLIED RESEARCH, AND DEVELOPMENT--WE SEE A STARTLING SHIFT IN RELATIVE PRIORITIES DURING THIS ADMINISTRATION. PLEASE NOTE THAT THIS AND THE OTHER CHARTS SHOW CONSTANT 1983 DOLLARS, WHICH MEANS THE CURVES HAVE BEEN CORRECTED FOR INFLATION AND REPRESENT ACTUAL PURCHASING POWER. YOU CAN SEE HOW BASIC RESEARCH HAS GONE FROM THE SMALLEST FRACTION OF THAT NON-DEFENSE R&D TO THE LARGEST, WITH A JUMP IN SHARE FROM 27 TO 38 PERCENT--MORE THAN A 40-PERCENT INCREASE. AT THE SAME TIME, DEVELOPMENT FUNDING HAS DROPPED BY NEARLY 50 PERCENT.

TO SEE MORE SPECIFICALLY HOW THAT FEDERAL SUPPORT FOR BASIC RESEARCH HAS GROWN, WE TURN TO THE CHART TITLED "BASIC RESEARCH OBLIGATIONS." IT SHOWS BASIC RESEARCH FOR THE FIVE LARGEST R&D FUNDING AGENCIES SINCE 1978--AGAIN, IN CONSTANT DOLLARS. AS YOU CAN SEE, ALL FIVE AGENCIES HAVE HAD STRONG AND CONSISTENT GROWTH, AND IN FOUR OF THOSE CASES THAT GROWTH FOLLOWS

LEVEL OR EVEN DECLINING REAL BUDGETS IN THE FIVE YEARS BEFORE.

FINALLY, ON THE CHART TITLED "BASIC RESEARCH OBLIGATIONS TO UNIVERSITIES AND COLLEGES" WE CAN SEE THE GROWTH IN BASIC RESEARCH FUNDS THAT HAVE GONE SPECIFICALLY TO UNIVERSITIES AND COLLEGES. HERE THE RESULT OF THE SCIENCE POLICY IS EVEN MORE PRONOUNCED. ALTHOUGH IT'S NOT SHOWN, WE COULD TRACE A CONSISTENT DECLINE IN BASIC RESEARCH FUNDING FOR UNIVERSITIES BACK TO 1968, AND WHERE THE CHART PICKS UP WE SEE THAT THERE WAS ESSENTIALLY NO GROWTH FROM 1979 TO 1981. HOWEVER, FROM 1981 TO THE LEVEL BEING PROPOSED FOR 1985, THIS SUPPORT FOR UNIVERSITIES GROWS BY 26 PERCENT--AGAIN, IN REAL TERMS.

MOREOVER, THE TRUE IMPACTS OF FEDERAL FUNDING ON UNIVERSITIES ARE EVEN GREATER, BECAUSE SO MUCH UNIVERSITY RESEARCH DRAWS ON FEDERAL INVESTMENT IN UNIQUE CENTRALIZED FACILITIES. SUBSTANTIAL AMOUNTS OF THE FUNDING THAT GOES TO FEDERAL AND NATIONAL LABS ACTUALLY SUPPORT UNIVERSITY RESEARCH IN PHYSICS, ASTRONOMY, MATERIALS SCIENCES, AND SPACE SCIENCES. SO I WANT TO STRESS THAT THESE GRAPHS AND NUMBERS REFLECT A POINT I'VE BEEN MAKING FOR AS LONG AS I'VE BEEN IN WASHINGTON--THAT DURING THIS PERIOD WE'VE BEEN SEEING THE STRONGEST SUPPORT

FOR BASIC RESEARCH IN TWENTY YEARS.

I WANT TO CALL YOUR PARTICULAR ATTENTION TO THE CONSISTENCY SHOWN IN THESE TRENDS, BECAUSE, AS I MENTIONED EARLIER, ONE OF THE MOST SERIOUS DETRIMENTS TO GOOD SCIENCE IS WHAT IS CALLED ROLLER-COASTER FUNDING. MOST GOOD RESEARCH PROGRAMS REQUIRE MANY YEARS TO PLAN AND CARRY OUT, JUST AS IT REQUIRES MANY YEARS FOR NEW IDEAS AND, ESPECIALLY, NEW TALENT TO DEVELOP, MATURE, AND BECOME PRODUCTIVE. SO I SEE THIS CONSISTENCY AS A MAJOR ELEMENT OF SCIENCE POLICY, AN ELEMENT THAT I HOPE THE ADMINISTRATION, THE CONGRESS, THE SCIENCE COMMUNITY, AND THE PUBLIC WILL BE ABLE TO MAINTAIN IN COMING YEARS.

NOW, WITH THAT AS PRELUDE, LET ME BRIEFLY DISCUSS SOME OF THE HIGHLIGHTS OF THE PRESIDENT'S PROPOSED FISCAL YEAR 1985 R&D BUDGET. DETAILED INFORMATION APPEARS IN THE ACTUAL BUDGET DOCUMENTS BEING SUBMITTED TO THE CONGRESS TODAY, SO I WON'T TRY TO BE COMPREHENSIVE IN MY COVERAGE.

TOTAL FEDERAL R&D WILL INCREASE IN 1985 TO $53 BILLION. OVER THE FOUR YEARS OF THE REAGAN ADMINISTRATION FEDERAL FUNDS FOR R&D HAVE INCREASED BY 52 PERCENT, WITH THIS YEAR'S INCREASE BEING 14 PERCENT. THE LARGEST INCREASE IN 1985 WILL GO FOR DEFENSE R&D, WHICH INCREASES 22 PERCENT

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AND WILL SUPPORT CONTINUING DEFENSE MODERNIZATION. WE'RE STILL IN THE POSITION OF HAVING TO PAY SPECIAL ATTENTION TO THESE DEFENSE MODERNIZATION NEEDS TO COMPENSATE FOR INADEQUATE FUNDING DURING THE PREVIOUS DECADE.

BASIC RESEARCH IS TARGETED FOR THE NEXT-LARGEST INCREASE, 10 PERCENT, AND WILL RISE TO $7.9 BILLION IN 1985. SINCE 1981 FEDERAL SUPPORT FOR BASIC RESEARCH HAS INCREASED BY 55 PERCENT, A GROWTH OF NEARLY $3 BILLION. HALF OF THAT SUPPORT GOES DIRECTLY TO UNIVERSITIES AND, AS I SAID, A GOOD BIT MORE IS DESTINED TO MAKE POSSIBLE FACULTY RESEARCH IN FEDERAL FACILITIES.

AS IN PREVIOUS YEARS, YOU'LL FIND WE'RE APPLYING THOSE BASIC RESEARCH INCREASES SELECTIVELY TO AREAS OF STRONG OPPORTUNITY AND EXCITEMENT. ALTHOUGH NOT READILY IDENTIFIED IN THE BUDGET INFORMATION, WE CONTINUE TO GIVE HIGH PRIORITY TO PROJECT SUPPORT FOR UNIVERSITY RESEARCH THROUGH AGENCIES LIKE NSF, NIH, DOE, DOD AND NASA. THIS KIND OF SUPPORT IS THE MOST IMPORTANT ELEMENT OF THE BUDGET IN CONTINUING ON THE PATH TO RESTORING THE HEALTH AND VITALITY OF OUR NATION'S UNIVERSITIES.

I SAID EARLIER THAT THERE ARE THREE BROAD GOALS EMBODIED IN OUR PROGRAMS FOR SCIENCE AND TECHNOLOGY. THESE RELATE

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TO ASSURING THE CONTINUING SUPPLY OF BRIGHT NEW TECHNICAL TALENT TO MEET NATIONAL NEEDS; TO SELECTING THE MOST IMPORTANT AND MOST RELEVANT FIELDS OF R&D TO PURSUE AND THEN PURSUING THEM AS WELL AS WE POSSIBLY CAN, AND TO STIMULATING NEW AND PRODUCTIVE PARTNERSHIPS THAT SPAN THE RANGE OF PEOPLE AND ORGANIZATIONS CONDUCTING R&D.

To help explain the kinds of specific activities that we're proposing to achieve those goals, I want to describe just a few of the FY 1985 initiatives in those contexts. Each of these examples embodies our determination to retain U.S. scientific and technical leadership in those fields we believe to be most important.

Without hesitation I would assign highest priority to stimulating and nurturing technical talent. Over the past several years I've had interactions with hundreds of our nation's industrial and university leaders. Almost to a person they echo that priority. Now, especially as the economy has resumed strong growth, industries that depend on technical talent are feeling the pinch. In many of the fast-growing fields--the ones that create new jobs and products for export--there simply aren't enough really good people to go around. We face problems of both numbers and quality. We face problems that threaten to put a brake on the ability of

OUR ECONOMY TO CONTINUE TO GROW.

As you know, one of the really exciting programs approved for FY 1984 was the National Science Foundation's Presidential Young Investigator Awards. I'm pleased to announce that the first 200 of these awards will be announced within a week or so, and NSF is already gearing up for the second round of 200 to be made in FY 1985. My understanding is that the universities involved have been very successful in lining up industrial support to match the federal funds, and we expect virtually all the awardees to realize the full $100,000 per year research support possible.

Part of the motivation for this program is to attract and retain top-quality young faculty in universities, especially in those fields where faculty shortages are severely limiting our ability to meet the growing demands by students for training. But, over the past year, in conversations with the academic and industrial engineering community, we've become increasingly concerned about another problem--the kind of training we're providing for the bulk of the undergraduates--those who expect to enter industry.

We're in the midst of a revolution in the way

ENGINEERS WORK AND THE WAY MODERN INDUSTRY OPERATES. THAT REVOLUTION IS SPURRED BY TODAY'S ALMOST UNBELIEVABLE LEAPS IN SCIENCE AND TECHNOLOGY--TECHNOLOGY THAT'S PUTTING POTENT NEW COMPUTER TOOLS IN THE HANDS OF THE PRODUCT DESIGNER AND THAT'S BLURRING THE DISTINCTIONS BETWEEN DISCIPLINES. SUCCESSFUL MANUFACTURERS ARE THOSE WHO UNDERSTAND THE ENTIRE PROCESS, FROM MARKETING TO DESIGN TO MANUFACTURING TO DISTRIBUTION--AND, INCREASINGLY, THE COMPUTER AND PEOPLE WHO KNOW HOW TO USE ITS FULL POTENTIAL ARE THE CENTRAL ELEMENTS IN THE PROCESS.

BUT VERY FEW OF OUR UNIVERSITIES ARE ABLE TO PREPARE THEIR STUDENTS TO OPERATE IN THAT KIND OF ENVIRONMENT. THIS ISN'T THEIR FAULT, BUT REFLECTS A COMBINATION OF LACK OF MODERN EQUIPMENT AND OVERBURDENED FACULTY WHO ARE STRUGGLING JUST TO KEEP UP WITH TEACHING DEMANDS. BUT WE SEE SEVERAL HOPEFUL SIGNS THE PROMISE TO HELP THEM OVERCOME THOSE LIMITATIONS.

IN PARTICULAR, INDUSTRY AND UNIVERSITIES ARE WORKING TOGETHER TO BETTER DEFINE THE KINDS OF WORKING ENVIRONMENTS THAT NEW GRADUATES WILL ENTER, AND INDUSTRY IS OFFERING VIRTUALLY NO-STRINGS-ATTACHED HELP TO MANY SCHOOLS IN THE FORM OF DIRECT FUNDING FOR NEW PROGRAMS AND MODERN EQUIPMENT FOR STUDENT USE. CERTAINLY WHAT I'VE SEEN IN THE PAST YEAR SUGGESTS THE DAWNING OF A NEW AGE OF

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ENLIGHTENMENT FOR ENGINEERING EDUCATION.

CLEARLY THE FEDERAL GOVERNMENT HAS A KEY ROLE IN THIS TRANSFORMATION. IN LIGHT OF THE KIND OF COMPETITIVE ENVIRONMENT THAT U.S. INDUSTRY IS GOING TO CONTINUE TO OPERATE IN FOR THE REST OF THIS CENTURY, WE WANT TO HELP OUR UNIVERSITIES PROVIDE THE BEST KIND OF TRAINING POSSIBLE.

SO IN 1985 NSF WILL INITIATE A NEW PROGRAM IN UNIVERSITIES TO INTEGRATE BOTH RESEARCH AND TEACHING NEEDS FOR ENGINEERING. THIS PROGRAM IS BEING DEVELOPED WITH THE BROAD PARTICIPATION OF THE ENGINEERING COMMUNITY AND THE NATIONAL ACADEMY OF ENGINEERING. THE AIM IS TO ESTABLISH CROSS-DISCIPLINARY CENTERS IN WHICH STUDENTS AND FACULTY CAN WORK ON BROAD RESEARCH PROBLEMS OF THE TYPE FACING INDUSTRY--AND USES THE MODERN TOOLS AND METHODS THAT INDUSTRY USES. THIS IS ONE OF SEVERAL NEW EFFORTS AT NSF TO IMPROVE ENGINEERING RESEARCH AND EDUCATION AT UNIVERSITIES--EFFORTS THAT I'M SURE DR. KNAPP WILL WANT TO DISCUSS WITH YOU WHEN HE PRESENTS THE NSF BUDGET.

NOW LET ME DESCRIBE A COMPLETELY DIFFERENT KIND OF PROGRAM THAT, IN AN IMPORTANT WAY, ALSO RELATES TO THIS CONCERN FOR TALENT. I'M REFERRING HERE TO THE DEVELOPMENT, ACQUISITION, AND AVAILABILITY FOR THE RESEARCH COMMUNITY

OF SUPERCOMPUTERS. I BELIEVE WE ALL AGREE THAT IT'S IMPERATIVE FOR OUR ACADEMIC RESEARCH COMMUNITY--FACULTY AND STUDENTS--TO HAVE OPPORTUNITIES TO WORK WITH STATE-OF-THE-ART COMPUTING TOOLS.

LET ME SUGGEST THREE MAIN REASONS FOR THIS IMPORTANCE. ONE IS THE DIRECT BENEFIT TO FRONTIER RESEARCH; SUPERCOMPUTER OFFER THE BEST KNOWN WAY TO ATTACK MANY LARGE-SCALE SCIENCE AND ENGINEERING PROBLEMS, A WAY TO MODEL COMPLEX PHYSICAL INTERACTIONS. SECOND IS THE OPPORTUNITY FOR YOUNG SCIENTISTS AND ENGINEERS TO LEARN WHAT SUPERCOMPUTERS CAN DO AND TO BECOME FAMILIAR WITH THEM. AFTER ALL, THESE PEOPLE ARE THE ONES WHO WILL BE DEVELOPING THE SUPERCOMPUTERS' POTENTIAL FOR SOLVING NEW KINDS OF PROBLEMS IN THE FUTURE. AND THIRD IS THE VITAL CONTRIBUTIONS THAT THE RESEARCH COMMUNITY WILL MAKE TO DESIGNING AND DEVELOPING THE SOFTWARE TO MAKE THE SUPERCOMPUTERS EVEN MORE USEFUL IN THE RESEARCH PROCESS.

MR. CHAIRMAN, I COVERED THESE AND OTHER TOPICS IN TESTIMONY SUBMITTED TO THIS COMMITTEE LAST NOVEMBER 16, SO I WON'T TAKE UP YOUR TIME BY GOING OVER THOSE ISSUES AGAIN. HOWEVER, I KNOW OF THE COMMITTEE'S STRONG INTEREST IN THIS TOPIC, SO I DO WANT TO BRIEFLY OUTLINE SOME SPECIFIC EFFORTS BEING PROPOSED FOR FY 1985.

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BOTH NSF AND DOE PLAN TO PROVIDE INCREASED ACCESS FOR UNIVERSITY RESEARCHERS TO SUPERCOMPUTERS, BOTH BY ALLOCATING GREATER AMOUNTS OF TIME ON SUPERCOMPUTERS AT NATIONAL LABORATORIES, SUCH AS THROUGH DOE'S MAGNETIC FUSION ENERGY COMPUTING NETWORK, AND BY INSTALLATION OF NEW SUPERCOMPUTING FACILITIES DEDICATED TO ACADEMIC USERS. NSF WILL ALSO BE INSTALLING A CLASS VII SUPERCOMPUTER AT THE NATIONAL CENTER FOR ATMOSPHERIC RESEARCH FOR USE BY THE ATMOSPHERIC AND OCEAN SCIENCES COMMUNITY.

IN PARALLEL EFFORTS, DOE, NSF, AND DOD WILL FUND INCREASED RESEARCH IN VARIOUS AREAS OF COMPUTER SCIENCE AND ELECTRONICS THAT WILL BE APPLICABLE TO FUTURE GENERATIONS OF SUPERCOMPUTERS. WE'RE CONFIDENT THAT THESE VARIED ACTIVITIES, IN CONJUNCTION WITH CONTINUED PURCHASE OF THE MOST ADVANCED SUPERCOMPUTERS FOR DIRECT GOVERNMENT USE, WILL, IN TURN, PROVIDE THE MARKET INCENTIVES TO PERMIT U.S. COMMERCIAL MANUFACTURERS TO MAINTAIN THEIR TECHNOLOGICAL LEADERSHIP IN THIS FIELD.

I ALREADY DESCRIBED THE IMPORTANCE OF PROJECT SUPPORT TO THE VITALITY OF UNIVERSITIES, BUT I SHOULD ADD THAT PROJECT SUPPORT IS ALSO A PRIMARY MEANS BY WHICH WE REACH THE SECOND GOAL--THE PURSUIT OF EXCELLENCE. I WOULD ONLY ADD THAT THE TRIED-AND-TRUE METHOD OF INVESTIGATOR-INITIATED, PEER-REVIEWED RESEARCH GRANTS

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HAS PRODUCED PHENOMENAL RESULTS OVER THE YEARS. THE FACT THAT U.S. SCIENTISTS WON FOUR OUT OF FOUR NOBEL PRIZES IN SCIENCE LAST YEAR REFLECTS ON THE EFFECTIVENESS OF THIS KIND OF SYSTEM FOR SUPPORTING BASIC RESEARCH.

ALTHOUGH THERE ARE MANY, I'LL OFFER ONLY ONE SPECIFIC EXAMPLE OF A 1985 INITIATIVE INTENDED TO HELP AMERICAN SCIENTISTS CONTINUE TO PURSUE EXCELLENCE. AND I OFFER IT BECAUSE IT REPRESENTS A FIELD OF SCIENCE IN WHICH THIS COUNTRY HAS BEEN A WORLD LEADER AND ALSO A FIELD THAT DEMANDS EXTREMELY CAREFUL--NOT TO MENTION WISE--DECISIONS ABOUT FUTURE PROGRAMS.

IN A SENSE, HIGH-ENERGY, OR PARTICLE PHYSICS, IS A FIELD OF SCIENCE THAT PUSHES HARDEST AT THE FRONTIERS OF KNOWLEDGE. THE QUESTIONS IT ASKS ARE IN MANY WAYS THE MOST FUNDAMENTAL IN NATURE, AND THE ANSWERS ARE SURELY AMONG THE HARDEST TO FIND. OVER THE YEARS THERE HAVE BEEN IMPORTANT DIRECT APPLICATIONS TO OTHER AREAS OF SCIENCE AND TECHNOLOGY OF KNOWLEDGE FIRST DERIVED FROM THIS KIND OF FRONT-LINE PHYSICS RESEARCH.

BUT WHAT I THINK WE HAVE TO REALIZE IS THAT FIELDS LIKE THIS ARE IMPORTANT AS MUCH FOR THE WAY THEY ATTRACT AND STIMULATE HUMAN INTELLECT AS FOR THEIR SPECIFIC RESULTS. IN A SENSE, FIELDS LIKE PARTICLE PHYSICS, OR

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ASTROPHYSICS, OR MOLECULAR BIOLOGY, OR MATHEMATICS ARE STIMULI FOR OUR BROAD NATIONAL STRENGTH IN SCIENCE AND TECHNOLOGY.

OF THOSE FIELDS PARTICLE PHYSICS IS NO DOUBT THE MOST EXPENSIVE TO PURSUE TODAY. IT'S THAT EXPENSZ THAT FORCES US TO MAKE, AS I SAID, WISE DECISIONS ABOUT WHAT COURSE WE'LL PURSUE. IT WAS THAT EXPENSE THAT LED TO A FUNDAMENTAL RETHINKING BY THE HIGH-ENERGY PHYSICS COMMUNITY, LAST YEAR, OF WHERE THE U.S. SHOULD BE GOING IN PARTICLE PHYSICS. THE RESULT OF THAT INTROSPECTION WAS THE DECISION TO TERMINATE A MAJOR ACCELERATOR PROJECT THAT WAS NO LONGER TIMELY AND FOCUS ATTENTION INSTEAD ON A BOLD STEP INTO NEW ENERGY REGIMES WITH AN ENTIRELY NEW ACCELERATOR LOOKING AT TRULY FOREFRONT QUESTIONS IN THE STRUCTURE OF MATTER.

I BELIEVE SUCH A PROJECT HAS STRONG MERIT IF IT CAN BE DESIGNED AND IF IT CAN BE BUILT FOR A REASONABLE COST, IN A REASONABLE TIME FRAME. THOSE ARE BIG "IFS," AND I DON'T THINK ANYONE CAN YET TELL US IF WE CAN MEET THOSE REQUIREMENTS. BUT WE'RE PROPOSING THAT IN FY 1983 WE BEGIN THE PROCESS OF TRYING TO FIND OUT. TO THAT END THE DEPARTMENT OF ENERGY WILL BEGIN R&D ON ADVANCED SUPERCONDUCTING PARTICLE ACCELERATOR CONCEPTS. THIS WOULD PERMIT US, AT SOME POINT LATER IN THIS DECADE, TO

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DECIDE WHETHER OR NOT TO PROCEED WITH THE NEXT-GENERATION MACHINE, A SUPERCONDUCTING SUPERCOLLIDER. QUESTIONS OF HOW, WHERE, HOW MUCH, AND, PERHAPS, WITH WHOM, ARE ALL DEFERRED UNTIL WE HAVE A BETTER HANDLE ON THE TECHNOLOGY. I EMPHASIZE THAT WE PROPOSE NO COMMITMENT TO PROCEEDING BEYOND THIS R&D; CONSTRUCTION, SHOULD IT APPEAR FEASIBLE, WILL HAVE TO BE DECIDED LATER.

THE THIRD GOAL I MENTIONED, STIMULATING PARNERSHIPS AMONG SCIENTISTS AND ENGINEERS IN UNIVERSITIES, FEDERAL LABS, AND INDUSTRY, REFLECTS THE PRESSING NEED TO IMPROVE THE TRANSFER AND APPLICATION OF NEW KNOWLEDGE TO NATIONAL NEEDS, PARTICULARLY IN INDUSTRY. I THINK WE'VE SEEN SOME REAL PROGRESS IN THE PAST FEW YEARS IN IMPROVING THESE INTERACTIONS, NOT SO MUCH BECAUSE OF ANYTHING GOVERNMENT HAS DONE AS MUCH AS BECAUSE OF THE BROAD NATIONAL AWARENESS OF THE NEED TO RESPOND TO THE OBVIOUS INDUSTRIAL AND MILITARY COMPETITION FROM ABROAD.

MY FIRST EXAMPLE OF BETTER PARTNERSHIPS FOCUSES ON THE FIELD OF AGRICULTURE. THERE'S LITTLE QUESTION BUT THAT WE HAVE MADE ONLY SLOW PROGRESS IN BRINGING THE BENEFITS OF THE MODERN BIOTECHNOLOGY REVOLUTION TO AMERICAN AGRICULTURE. THE RESULT, I'M AFRAID, IS THAT WE'VE FAILED TO TAKE THE PRUDENT STEPS NECESSARY TO PROTECT THE ENORMOUS WORLD LEADERSHIP WE'VE ENJOYED FOR SO LONG IN AGRICULTURE.

We've already seen--painfully--how aggressive competitors who adopt new technologies and run with them can make severe inroads on what American industry assumed was a guaranteed market. Automobiles and consumer electronics come most readily to mind. I would hate to have to add agriculture to that list twenty years from now. Let me add that I don't expect to. We have tremendous resources in this country that should enable us to maintain and extend our world lead--but we have to start now to incorporate the fruits of molecular biology and its offshoots into a new field of agricultural biotechnology. To accelerate that process, in FY 1985 the Department of Agriculture will greatly expand its competitive grants program. This will include a substantial new agricultural biotechnology research effort within that program.

I'd also like to bring the Committee up to date on another attempt to stimulate new partnerships--the Center for Advanced Materials at Lawrence Berkeley Laboratory that is now underway. The project has benefitted during the past year from thoughtful review and recommendations from the materials science community, recommendations that are being implemented. Our original objectives for the center are unchanged--a place to bring together a range of materials and other scientists

FROM ACADEMIA, INDUSTRY, AND FEDERAL LABORATORIES TO WORK ON PROBLEMS OF FUNDAMENTAL IMPORTANCE TO FUTURE TECHNOLOGY.

MR. CHAIRMAN, I CAN'T THINK OF ANY EFFORT UNDERTAKEN BY MY OFFICE THAT IS MORE PERTINENT TO THIS GOAL OF PROMOTING PARTNERSHIPS THAN OUR EFFORT TO IMPROVE THE OPERATIONS OF THE NATION'S MORE THAN 700 FEDERAL LABORATORIES. I'D LIKE TO BRING YOU UP TO DATE ON THE PROGRESS BEING MADE ON IMPLEMENTING THE RECOMMENDATIONS OF THE WHITE HOUSE SCIENCE COUNCIL'S REVIEW OF FEDERAL LABORATORIES. AS YOU KNOW, THIS REVIEW WAS DONE UNDER THE LEADERSHIP OF DAVID PACKARD AND RESULTED IN A SERIES OF RECOMMENDATIONS THAT WERE PRESENTED TO THE PRESIDENT LAST JULY. FOLLOWING THAT PRESENTATION, THE PRESIDENT INSTRUCTED OSTP AND OMB TO LEAD AN INTERAGENCY EFFORT TO WORK ON WAYS TO IMPLEMENT THE RECOMMENDATIONS IN THE PANEL'S REPORT--AND HE DIRECTED THE HEADS OF FEDERAL DEPARTMENTS AND AGENCIES TO WORK WITH US IN DOING THAT.

THE PACKARD PANEL, AFTER MORE THAN A YEAR OF STUDY OF THE FEDERAL LABS, CONCLUDED THAT THE NATION COULD BE DERIVING FAR MORE BENEFIT FROM THESE VALUABLE R&D RESOURCES, AND THEY RECOMMENDED CHANGES IN FIVE MAJOR AREAS TO HELP IMPROVE THEIR EFFECTIVENESS. WITHOUT GOING INTO DETAIL, I WOULD JUST INDICATE THAT THE RECOMMENDATIONS CALLED FOR

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CLEARER MISSIONS FOR THE LABS, FOR CHANGES IN THE PERSONNEL SYSTEMS TO ATTRACT AND RETAIN TOP TECHNICAL TALENT, FOR MORE STABLE FUNDING AND MORE AUTONOMY FOR THE LABS THEMSELVES IN MANAGING THEIR RESEARCH, AND FOR BROADER INTERACTIONS BETWEEN THE LABS AND OTHER PUBLIC AND PRIVATE SECTOR R&D ORGANIZATIONS.

OVER THE PAST HALF YEAR AN INTERAGENCY COMMITTEE HAS BEEN MAKING GOOD PROGRESS IN DEVELOPING APPROACHES TO CARRY OUT THE RECOMMENDATIONS. THEY'VE DONE THIS BY WORKING WITH LAB AND AGENCY OFFICIALS, WITH POTENTIAL USERS OF LAB RESULTS, AND WITH THE ORIGINAL WHITE HOUSE SCIENCE COUNCIL PANEL. AND IN THIS REGARD I WANT TO SPECIFICALLY ACKNOWLEDGE THE TREMENDOUS CONTRIBUTION THAT DAVID PACKARD HAS MADE AND CONTINUES TO MAKE IN THIS EFFORT.

SOME OF THE RECOMMENDATIONS, SUCH AS THOSE ENCOURAGING GREATER INTERACTION WITH INDUSTRY AND UNIVERSITIES, CAN BE IMPLEMENTED DIRECTLY BY THE ACTIONS OF THE LABS AND PARENT AGENCIES; OTHER RECOMMENDATIONS, SUCH AS THOSE CALLING FOR CHANGES IN FEDERAL PERSONNEL REGULATIONS, WILL REQUIRE LEGISLATION. AS SPECIFIC PROPOSALS BEGIN TO TAKE SHAPE, THE INDIVIDUAL AGENCIES, AS WELL AS MY OFFICE, WILL DISCUSS THEM WITH THE CONGRESSIONAL BODIES THAT HAVE OVERSIGHT RESPONSIBILITIES IN THESE AREAS.

WE HOPE THAT THE BULK OF THIS WORK WILL BE COMPLETED BY THE TIME WE REPORT BACK TO THE PRESIDENT--JULY 1, 1984--THOUGH WE ALL RECOGNIZE THAT OPTIMIZING THE RETURN ON OUR MASSIVE INVESTMENT IN FEDERAL LABS--ABOUT ONE-THIRD OF THE TOTAL R&D BUDGET--DEMANDS CONTINUAL ATTENTION TO THE NATION'S R&D CLIMATE AND DEMANDS READINESS TO CHANGE AS THE TIMES CHANGE.

MR. CHAIRMAN, I CHOSE THESE FEW EXAMPLES OF FY 1985 INITIATIVES TO GIVE A FLAVOR FOR HOW SCIENCE POLICY IS IMPLEMENTED. I COULD AS EASILY HAVE CHOSEN MANY OTHER EXAMPLES, BECAUSE THE PROPOSED PROGRAM FOR FY 1985 IS INDEED EXCITING. WE HAVE NEW SPACE SCIENCE MISSIONS, SUCH AS THE UPPER ATMOSPHERE RESEARCH SATELLITE AND THE MARS CLIMATOLOGY/GEOSCIENCE ORBITER, IN ADDITION TO THE SPACE STATION PROPOSED BY THE PRESIDENT LAST WEEK. WE HAVE AN EXCITING PROPOSAL FOR A CONTINUOUS ELECTRON BEAM ACCELERATOR FACILITY TO FOCUS ON THE ROLE OF QUARKS IN ATOMIC NUCLEI, AN IMAGINATIVE PROJECT UNDER THE DIRECTION OF A SOUTHEASTERN UNIVERSITY-BASED CONSORTIUM. NSF WILL BEGIN CONSTRUCTION OF A LONG-AWAITED AND UNIQUE ASTRONOMICAL FACILITY, THE VERY LONG BASELINE ARRAY OF RADIO TELESCOPES. NSF WILL ALSO BEGIN WORK ON DEFINING A POSSIBLE CONTINENTAL DRILLING PROGRAM TO INVESTIGATE IMPORTANT PHENOMENA DEEP IN THE EARTH'S CRUST. AND THERE ARE MANY MORE THAT YOU'LL BE HEARING

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ABOUT AS THE INDIVIDUAL AGENCIES APPEAR BEFORE THE CONGRESS.

FINALLY, I KNOW OF THE COMMITTEE'S INTEREST IN THE PUBLICATION, SCIENCE INDICATORS. TO THOSE OF US DEALING WITH SCIENCE POLICY ISSUES, THERE'S NO QUESTION OF THE IMPORTANCE OF GOOD DATA ON FUNDING AND PERSONNEL FOR SCIENCE AND TECHNOLOGY. THE CHARTS WE SAW EARLIER ARE AN EXAMPLE OF HOW EFFECTIVELY SUCH DATA CAN GIVE US FEEDBACK ON PERCEPTIONS AND MISPERCEPTIONS. IN MY OWN OFFICE WE REFER CONSTANTLY TO SUCH INFORMATION, AS I'M SURE THE MEMBERS OF THE COMMITTEE DO ALSO.

AS AN HISTORICAL DOCUMENT I BELIEVE THE SCIENCE INDICATORS IS EXTREMELY USEFUL. BUT I THINK WE ALL RECOGNIZE THAT IT HAS SERIOUS LIMITATIONS IN HELPING US TO UNDERSTAND WHAT'S HAPPENING CURRENTLY. FOR EXAMPLE, ECONOMIC CHANGES OVER THE PAST TWO YEARS, AND CHANGES IN THE ACTIVITIES OF BOTH GOVERNMENT AND INDUSTRY IN RESPONSE TO THOSE CHANGES, CAN HARDLY BE REPRESENTED IN DATA THAT, FOR THE MOST PART, EXTENDS ONLY AS FAR AS 1982. WE'RE HERE TODAY DISCUSSING PROGRAMS FOR 1985 AND THE EXECUTIVE AGENCIES ARE STARTING NOW TO PLAN PROGRAMS FOR 1986. SO THE GAP IN DATA CAUSES SOME OBVIOUS PROBLEMS. SCIENCE INDICATORS IS THE THE BEST SUMMARY WE HAVE--BUT IT HAS THESE OBVIOUS WEAKNESSES.

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WE SHOULD ALSO REALIZE, QUITE APART FROM THOSE INHERENT LIMITATIONS, THAT NUMBERS ARE NOT THE ONLY MEANS OF EVALUATING THE STATE OF SCIENCE. YES, NUMBERS ALLOW US TO MAKE IMPORTANT COMPARISONS, BUT WE ALSO MUST LOOK FOR OTHER MEASURES TO EVALUATE THE VALUE OF SCIENCE PROGRAMS, TO GET A SENSE OF THEIR QUALITY AND BENEFITS.

WE'VE BEEN DISCUSSING THESE ISSUES WITH THE NATIONAL SCIENCE BOARD AND EXPECT TO BE ABLE TO DEVELOP SOME MEANS TO IMPROVE THE USEFULNESS OF Science Indicators, AS WELL AS TO DEVELOP SOME OTHER, "QUICK-LOOK" MECHANISMS TO PROVIDE MORE CURRENT DATA ON SPECIFIC TOPICS. I'M ESPECIALLY INTERESTED IN DEVELOPING MORE TIMELY INFORMATION ON INDUSTRIAL SPENDING AND PERFORMANCE OF R&D AND ON INTERACTIONS BETWEEN THE THREE SECTORS OF THE WORLD OF SCIENCE AND TECHNOLOGY--UNIVERSITIES, FEDERAL LABS, AND INDUSTRY.

MR. CHAIRMAN, THIS CONCLUDES MY FORMAL PRESENTATION. I WOULD BE HAPPY TO RESPOND TO QUESTIONS FROM THE COMMITTEE.

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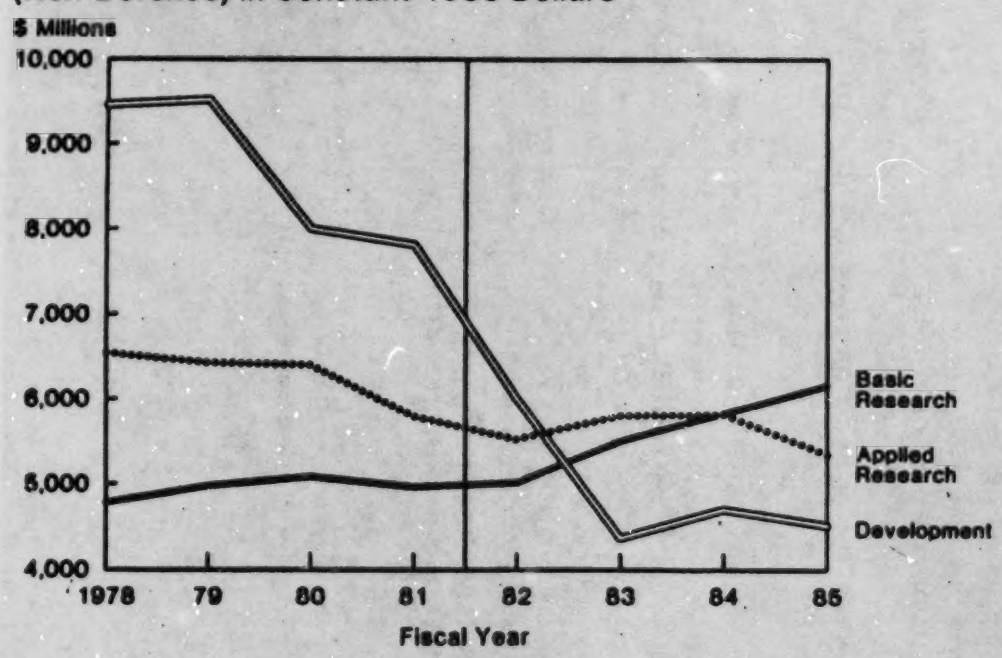
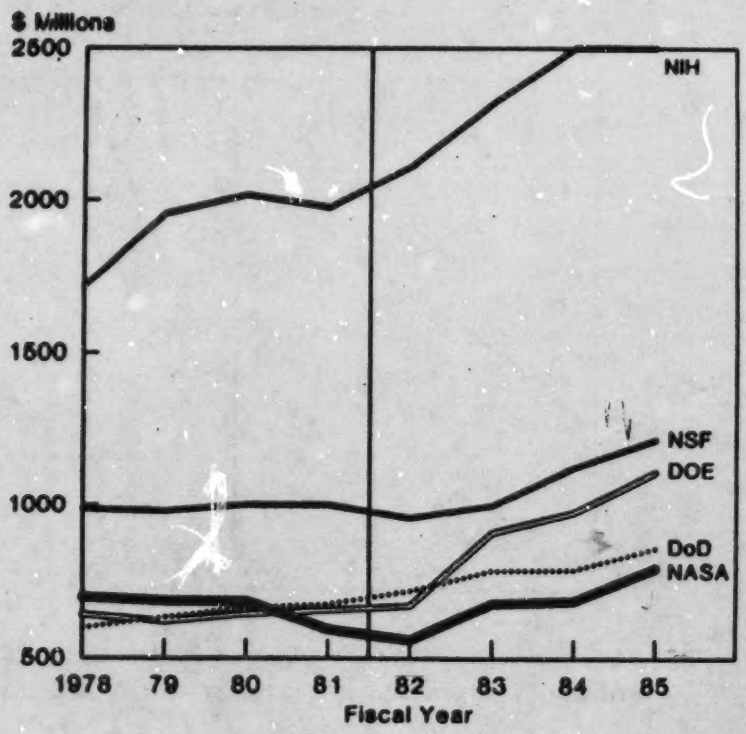
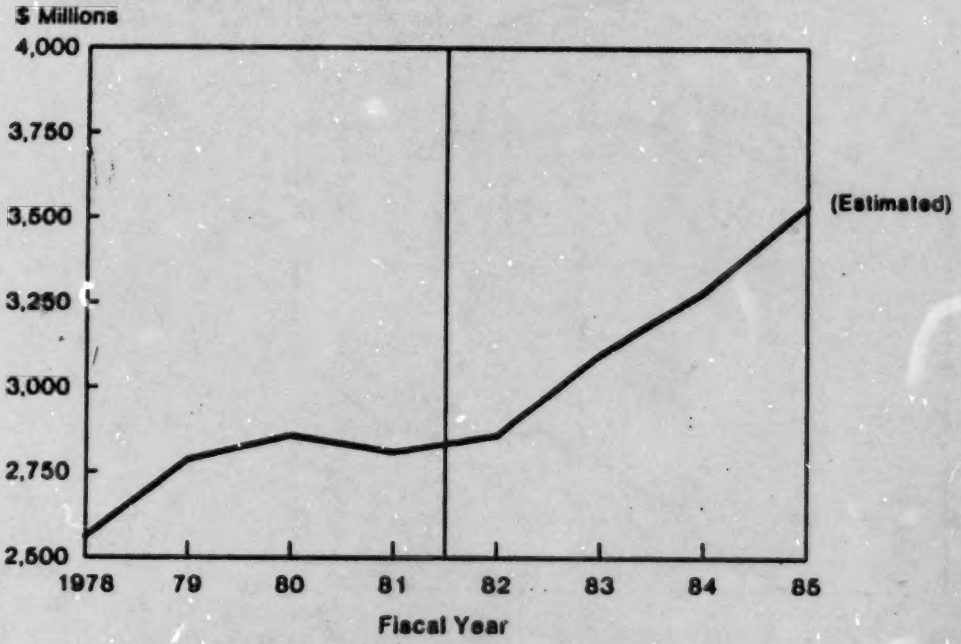


Basic Research Obligations (Constant 1983 Dollars)



Basic Research Obligations to Universities and Colleges (Constant 1983 Dollars)



The CHAIRMAN. Thank you very much, Dr. Keyworth, for a very fine statement, and let me commend you for some very significant increases, particularly in basic research.

You mentioned that since 1981, Federal support for basic R&D has increased by 55 percent, or about $3 billion—I think I am interpreting accurately what you've—what has happened in the private sector for funding, for basic research, particularly at universities?

Dr. KEYWORTH. Mr. Chairman, I think—first, the answer is some very exciting things. We must remember that the industrial contribution to academic research is very, very small, less than 10 percent of the total, but I would say that 10 percent is immensely important and it is growing very rapidly. It is immensely important for two reasons: First of all, it brings those whose responsibility or training closer to the environment in which their students are likely to be employed in the future; and second, it provides a very challenged set of American industries an opportunity to draw upon some of the top talent in the nation.

So, the number is not large. It is growing very rapidly and, Mr. Chairman, unfortunately, neither we nor anyone at this time possess the required statistics to tell us just how rapidly that is growing. But I would—I would be willing to speculate and say that from all the evidence we have been able to get, I think that number has at least doubled during the period of the 55-percent increase in Federal R&D expenditures.

The CHAIRMAN. So you would say there have been approximately double from what the Federal contribution has been.

Dr. KEYWORTH. The 1985 contribution from industry is likely to be double——

The CHAIRMAN. What it was in——

Dr. KEYWORTH [continuing]. What it was in 1981.

The CHAIRMAN. Very good. You also discussed the NSF and DOE plans for access for university researchers to supercomputers and by installing supercomputer facilities dedicated to academic users. Do you know approximately what funding level we're talking about and how many we're—are we talking about numbers of computers or——

Dr. KEYWORTH. Within—let me make——

The CHAIRMAN. I realize this is the first year of this, but——

Dr. KEYWORTH. I don't have the number on the tip—but I think, within DOE and NSF specifically in this area, I think we are talking about a sum that will be between $30 and $40 million. It is the beginning of a program. We are trying to, and have been aggressively trying to solicit well thought out proposals from a number of universities around the country. I think it is going to have to be one of those programs that we emphasize, but each year take a careful step and look at just how promising the proposals are.

I might remark, or point out, that in the past, very few universities have had any direct access at all to the largest supercomputers. They have been primarily in industry and in national and Federal laboratories.

This is a rather drastic change. It is the beginning of a new program and we will see several new supercomputers bought with fiscal 1985 funds if approved.

The CHAIRMAN. Then—we had some hearings in November which you were unable to attend, but you did submit a statement, and it was our—or the testimony we received—that the Government had a large responsibility in the development of supercomputers for the national interest and I assume you concur with that by what the Administration is doing in these programs.

Dr. KEYWORTH. Enthusiastically.

The CHAIRMAN. You mentioned the Packard report as it related to the national laboratories. I understand that the ERAB panel has been also doing a report. How does it compare with the Packard report? Are they parallel or what recommendations from the ERAB committee might be implemented?

Dr. KEYWORTH. They are very definitely parallel. Of course, the ERAB group was established to look at the DOE's national laboratories; the Packard panel was chartered with looking at 720-odd laboratories across the country.

Their views and recommendations are very much mutually supportive and I think their principal emphasis are really the same. We really are wrestling with an issue here of a mission whose clarity—clear definition has simply dwindled over a period of 30 and 40 years in most cases in many of the laboratories.

The CHAIRMAN. Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

Along this same line, Dr. Keyworth, of the three studies, they did have—on the laboratories, they did have quite a—quite a bit in common, and the reports appear to agree that the individual laboratories are given insufficient flexibility of operation.

Another point was that several of the laboratories do not operate with any specific mission. To what extent does the administration give substance to all of these—all of these reports?

Dr. KEYWORTH. Mr. Winn, I think there is no question at all that the central recommendations have a lot of substance behind them, a lot of proof, and for that matter, in many cases have been known for years. I think it is the comprehensive nature of these studies that is particularly important right now, and the urgency—urgent needs that we have to draw upon this tremendous talent.

What are we doing specifically to provide substance to this? First of all, we are working with the agencies to try to clarify exactly what those missions and mission responsibilities would be. As I mentioned in my testimony, we are working with the Office of Personnel Management and the Congress to address the salary scales in order to attract the best possible people.

You, Mr. Winn, addressed what I think is as critical as any other single area; the ability of the laboratories themselves to flexibly address areas of particular importance. It has not been there.

The laboratories have been micromanaged disastrously. I would look at the DOE laboratories in particular and say that from—if I may say—from both sides of Government, they have been micromanaged to a point where much of the capability has been constrained. I believe that everyone is agreed that we should allow more autonomy to those laboratories, that we should give the directors more responsibility, and I feel very strongly myself that, as Dave Packard recommended, that they should have a substantial sum, 5 to 10 percent, of their overall funds available for the direc-

tor's discretionary use. Discretionary, mind you, does not mean without very careful controls and oversight. The fact is, what we are talking about is giving a director an opportunity and holding him very strong responsible for this.

But I would certainly emphasize that when we are talking about one-sixth of the entire public- plus private-sector R&D of this country combined, and more than that in terms of the fraction of the technical talent of this Nation, it is today, with the competition and challenges that we face from abroad, I think it is absolutely urgent that we use this immense capability far, far better than we have in the past.

Mr. WINN. How soon do you think we can expect some results, as you address the concerns of these reports?

Dr. KEYWORTH. We're beginning to see already some results, some response from within the laboratories and some response from within agencies, but I would say this, before I testify again before you next year, I would expect to be able to come with clear, concrete, tangible evidence, and changes.

Mr. WINN. Another thing that concerns me about the national laboratories- for instance, I'm advised by DOE that the replacement value of the national laboratories under DOE's responsibility alone amounts to some $8 billion, and still—and also, if normal trends continue, I would expect that amount to depreciate at the rate of about at least 3 percent per year, and still, in the routine maintenance of the national labs it would cost about $250 million a year. But in your requests year after year, we get requests of only about $40 or $50 million.

My point is, how long do you think we can continue to obtain the beneficial results from the assets which are undermaintained? Maybe we'd call it the "living off of your capital." How do you judge that?

Dr. KEYWORTH. Mr. Winn, I'm going to answer that question with a mixture of my experiences here and from my previous incarnation. I have not paid a lot of attention in my addressing of science policy to the particular question you raise, but I have looked at it, and I, too, am very deeply concerned that the so-called GPP funds within the DOE have been alarmingly low for an alarmingly long period of time, and I assure you that the implications of that are clearly felt across all the DOE laboratories.

It is essentially, in a no small way, is responsible for a severely decaying infrastructure that has prevented their ability to reap some of the very clear benefits that should have been obtained with that equipment.

Mr. WINN. Well, my time is up, but I am just glad that OSTP is aware of these deficient requests, and I hope you'll take a good look at them.

Dr. KEYWORTH. Thank you.

The CHAIRMAN. Thank you, Mr. Winn.

Mr. Glickman.

Mr. GLICKMAN. Jay, it's a pleasure to see you here today. I'd just like to pursue three quick lines of questioning. One is your emphasis on basic research at the expense of applied research. I am very concerned that our friends in Western Europe and Japan are not making the distinctions that you are, that they—their universities

and their governments and their private sector—granted it's different than ours—are doing an extensive amount of work in research and not making this artificial difference that we have a fixation on in the United States.

I notice that in the defense area, there is a general substantial support in R&D by in both applied and basic research, and I wonder if you would again tell me why we should not, at the same time we're increasing basic research, we should not also increase some applied research as a way to compete with our friends around the world who are doing a damn good job of building products as or more competitively than we are.

Dr. KEYWORTH. As you know, Mr. Glickman, that's an extremely comprehensive question, but let me attempt to address it.

First of all, DOD is a very special agency, because DOD is also not only the supporter, but clearly the user. It has a mission itself and it is investing its R&D funds in order to carry out that mission. So it is more analogous to an industry committing its R&D funds than to an agency such as the National Science Foundation. And as you said, they clearly put, in fact, 90-odd percent of their total R&D budget is clearly in applied research and development.

In other agencies, I believe that there are, and have been, substantial funding in applied research and in development areas than can and is being targeted far more effectively. You and I have worked closely together on aeronautics, for example, and I think we have shared a very much mutual concern on this, as have many other members of the committee.

That is an excellent example because we have, I believe, been able to, first of all, turn the funding around in many of its directions. We have been able to enhance it because of the clear importance of the area, but across the board, to me, the criticality of it, the essential components of it are nowhere near as strong or numerous as they are in basic research, and rather than look at the way that the Germans or others do it, I might point out that the Germans did not win any Nobel Prizes last year. We won four out of four.

In spite of the fact that the Germans are definitely continuing to introduce some very real competition, we are not losing to the Germans because of this by any means. But I fear that the potentially greatest constraint on our ability to grow economically is a shortage of talent. The talent comes from basic research primarily.

Mr. GLICKMAN. OK, well, I guess my point is that I think it needs a combination of the two, depending upon the relative subject area and I just would hate to put this kind of ideological kabash on applied research in some areas where it may be appropriate, like in the area of aeronautics or others, and I'm sure that Congress will work with you on this.

Let me move quickly to the space station. I'd like to quote a gentleman named Thomas Donahue, Chairman of the Space Science Board of the National Academy of Sciences, who says the following: "If the decision is to build a space station that is political and social, we have no problem with that, but don't call it a scientific program."

I wonder if you might comment on that because, obviously, that's the major new initiative of this administration this year. It's going

to be before this committee, deciding whether we have the funds to commit to it, deciding whether it's the appropriate way to go.

Dr. KEYWORTH. I think the fact that I am a strong supporter of the space station and a strong admirer of Tom Donahue's and believe that that statement is basically correct are completely consistent. The fact is, the space program is much more than science, as we all know. Science is one of its component values that we nurture and pay particular attention to.

It has enormous symbolic value. It has enormous value for defense and it has enormous value for pushing the frontiers of manufacturing and exploration. No question. What Dr. Donahue said was simply that he cannot—and he and I have discussed this—that he cannot see that the space station will significantly impact our ability to pursue space sciences, and in that sense, I think most of the scientific community supports him.

Again, I distinguish here——

Mr. GLICKMAN. Do you disagree with what he says?

Dr. KEYWORTH. No, I think he is correct. But I also, in terms of the science alone, the primary arguments for the space station, which are very strong, are not in science; they are in manufacturing; they are in representing essentially a doorway to further exploration; they are allowing us to use and exploit the obvious environment, and the high vacuum and microgravity, of course, and they are also allowing us to conduct a broad family of biological experiments with humans and animals.

Mr. GLICKMAN. Thank you, Mr. Chairman.

The CHAIRMAN. OK Mr. Glickman.

Mr. Lujan.

Mr. LUJAN. Thank you, Mr. Chairman.

I have two questions: one on space and one on energy. This committee, at least most of us on this committee, I guess, are happy to see the initiatives of the space station, the Mars orbiter, the atmospheric research, and of course, moving on with the space telescope.

On the space station itself, do you see it as simply a stepping stone for a moon colony or further exploration of space or as a factory that is our end.

Dr. KEYWORTH. A fundamental question, Mr. Lujan, and I will try my very best to avoid donning my white coat in answering it, as I said in answer to the previous question, there are a number of component arguments for the space station.

But certainly a most fundamental one is that if you wish to move a body of human being, an experiment, a vehicle, outside the earth's gravitational fields to explore other planets and so on, you must expend a certain amount of energy, and a bulk of that energy is used in simply getting you up to the altitude of the space station. So in that sense it is a potential doorway for further exploration. And, yes, I look at that as being the single most important aspect of the space station. And I think in future years, next year, the year after, all of us, and I think the public in general, will be doing a lot of talk about the long-term goals for NASA, the next 20-year goals.

Mr. LUJAN. Yes.

Dr. KEYWORTH. I think it will be exciting. I think it is more critical than in any other area which I am involved, to make it a clear-

ly public issue because the space program is a uniquely public property.

Mr. LUJAN. I think you have answered the question very well.

The followup question to that is—and I am sure this was going to come up in the committee in your statement, in your prepared statement, not the one that you read—it is completion of the shuttle fleet with a delivery of a fourth orbiter in December 1984 and continuing acquisition of the spare parts. Do you see a conflict between moving forward on the space station and the fifth orbiter, funding-wise?

Dr. KEYWORTH. At the moment, I don't. But I think you are addressing a real possibility that we all have got to consider in the future. If, for example, we were to continue down the road with the option—develop the option of extending orbiter life of the shuttle, then I think that seriously impacts the need for a fifth orbiter.

Mr. LUJAN. But your statement would indicate that four is enough.

Dr. KEYWORTH. With the present flight schedule, four is enough, absolutely. And the only thing that could alter that statement and require a fifth is expansion of man's role in space—or primarily man's role in space either by the permanent—by the space station or simply by extended orbiter use.

Mr. LUJAN. Let me change—because in the interest of time I only have 5 minutes—to the energy field. I was reading—and I can't tell you right now whether it was the Grace Commission Report or the Heritage Foundation recommendations, but it may have been in one or the other, or both, discontinuing our strategic oil reserve program, the enrichment program in Portsmouth, and the Synthetic Fuels Corp.

Are those likely to be supported—and you may know whether it was the Grace Commission or not in each one of those three—and are those likely to be supported by the administration?

Dr. KEYWORTH. I think they actually may very well have been supported by both—the Heritage Foundation and the Grace Commission. I certainly can't say, other than the fact that they are all issues that clearly we will be and have been addressing. There must come a time when the Strategic Petroleum Reserve has reached a strategically important level.

Mr. LUJAN. Well, the point they made was that we no longer just depend on the Middle East for oil, that there's all kinds of sources and so, therefore, we are not subject to the embargos that we were in the past.

Dr. KEYWORTH. If I may be so bold——

Mr. LUJAN. Sure.

Dr. KEYWORTH [continuing]. As to offer my personal opinion——

Mr. LUJAN. Yeah.

Dr. KEYWORTH [continuing]. I think we are rapidly approaching the point—because of the point you just mentioned—where we have adequate strategic reserves, because our dependency is no longer in a unique area. We are not so vulnerable. And it is very large.

GISEP, of course, the isotope separation plant, is another particular issue where there is no economic demand right now to enhance our technical capability, and one must pay attention to put-

ting that revenue stream back into making ourselves more competitive in the marketplace today. And with synthetic fuels I think we've seen an increasing public awareness of the fact that government underwriting the cost of a barrel of oil was very expensive to them in the long run.

Mr. LUJAN. Thank you. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. Lujan.

Mr. Brown.

Mr. BROWN. Dr. Keyworth, I won't applaud all of the things that you have said in your statement , with which I very strongly agree, I think you have made a good statement.

You have commented both, I think, in this statement and other times, about the adverse effects of what you, I think, might call a roller coaster situation in the funding of vital programs, like basic research, fluctuations up and down, and uncertainty, are not conducive.

The statement that was quoted by Mr. Glickman with regard to the Academy's Space Board and the Earth station, of course, was made in similar form about the Moon landing and about the shuttle—that they did not contribute to science and, of course, the Defense Department makes a similar statement in some regards that they don't contribute to defense; and they are, therefore, less than enthusiastic.

But the point I am trying to make is that what the Science Board feels is, this detracts from the investment in the science that is in the space program. And my question is: Do you see any reason why we shouldn't maintain a strong science program in space? Why we should avoid the roller coaster effect? Why we should not continue to maintain adequate funding for the planetary program, the space telescope program, the other science programs that are involved in space, even though we are going ahead with the space platform?

Dr. KEYWORTH. Mr. Brown, since you have actually articulated the answer to an earlier question far better than I, let me just add a few more things.

I, of course, totally agree with you. The scientists are only one of the considerations—offer only one set of recommendations at the table. And what I am saying is that Mr. Donahue offered a fair one.

Second, we all know that the scientists are reeling from the period 1972 to 1982 when increasing costs of the space shuttle terminated many important science projects and we saw space science go largely into a single area of planetary exploration. They are reeling from that and they have good memories, and they fear, as I do, this roller coaster.

I point to the budget that we submit today, and note that not only have we taken a major new start in the space station but we have also provided important new strength to the third area of space sciences with the UR's. I think we have a strong astronomy program and astrophysics, beautiful. I think it is strong for many years to come with space telescope and GRO, planetary exploration—very healthy, I believe.

Now we have taken a step to strengthen a third, so-called solar terrestial science. I think we have very healthy science right now

and I think we all must work hard to maintain that so that the fears that Tom Donahue doubtless represents are not justified.

Mr. BROWN. Well, this committee would like to help you maintain that proper balance. I am sure you know even though we argue about it at times, that that has been our primary consideration.

Let me raise two other areas in which the matter of balance is also important. You have stressed properly the importance of the funding of supercomputers. You have also stressed the importance of training of the best young investigators. And yet when this administration came in, this committee had been seeking more funding for supercomputers and enhanced funds for scientific and engineering training and education, and they were zeroed out.

Now, you have suddenly invented new programs which you think are far superior, apparently, but you are not yet back to the level that this committee proposed several years ago, and which are recommended by some of the studies that have been made.

Now, can you explain why your approach is so much better than what the committee wanted?

Dr. KEYWORTH. Because I think a lot of time has passed, and we have come to understand clearly something that was not possible to understand 3 and 4 years ago, and that was the exact nature of how American industries were going to compete with the new Japanese thrust in supercomputers. They were not prepared. We have worked very closely with them to try to understand where they are constrained. And we feel that these programs are particularly tuned to exactly what they represent as a need: adequate talent, attention to software and architecture, and some key areas of generic technology development, and then simply access.

One of the problems that has already constrained, as you well know, in the supercomputer area, is that a single company may only manufacture 15 in a year. And a small statistical fluctuation of that small number can drive them right out of business. And we have tried to consolidate Government purchases across the board to reduce that instability and allow them better ability to predict.

So I think it's simply—it's not that we are coming at this from different points at all. I think we are reacting to the problem of today.

Mr. BROWN. I would feel much better if I felt that you were really interested in improving the focus rather than just rejecting had been done before because you didn't invent it. That's going to happen in every administration. And we don't like it in this committee to have it happen in every administration, because we think some of these programs are important to maintain that continuity and avoid that roller coaster effect that you have properly pointed to as having an adverse impact on the program.

Dr. KEYWORTH. Mr. Brown, I think 8 years will give us an excellent opportunity to work together on that. [Laughter.]

Mr. BROWN. I will not respond to that even though I——

[Laughter.]

The CHAIRMAN. Thank you, Mr. Brown.

Mr. Gregg.

Mr. GREGG. Thank you, Mr. Chairman. And I agree 8 years would give us an excellent opportunity.

Initially I have to get off my first question about acid rain, and the President mentioned it. I am interested in knowing what your current assessment of the knowledge—scientific knowledge is in acid rain—and what science do you feel still has to be done in specifics, if possible.

Dr. KEYWORTH. Thank you. I think there are two basic scientific questions that are included in understanding the acid rain issue. One, of course, is causality. Does—do our powerplants and coal-burning factories produce acidity in lakes in certain parts of the country? I think the answer has been answered scientifically—they do. Causality is established.

The second question, then, is required—a required piece of knowledge or science before, I believe, any major expenditure can be made is just what is the nature of that causality? How does—what does it depend upon in particular? If you stop one thing in one State, what happens hundreds of miles away? That, we do not know. We simply do not know.

And I believe that what we should do, and will do, is make a major thrust in our research programs to target them solely in those areas—and you are seeing major increases in EPA's R&D budget for just this reason—to very carefully focus them toward answering some of the very basic questions on if we do what, what will be the impact.

In other words, what we wish to do is develop the science so that we can make reasonably intelligent cost-effect analysis of this, which we cannot do at the time.

Mr. GREGG. Thank you. I appreciate that conciseness.

In the area of science and engineering education, which is another interest of mine, I noticed you talking a lot here about basic science. Obviously, NSF funding in science education is important. I notice it is flat. I guess I can understand now that it as long as it is anticipated that after we serve the next 5 years as a party, there is going to be a significant upturn once we have got the programs on line.

In other words, I am willing to accept the flat funding this year as long as I know that that's because we are trying to get our house in order so that next year as we start to get more heavily into this, we are going to be able to spend the dollars effectively.

Is that the plan?

Dr. KEYWORTH. Yes. But let me answer it this way, if I may, by an analogy. I certainly don't want to be, nor do I think any of us, in the position of the stereotype parent who ignores a child for 18 years and then with a deep feeling of remorse and guilt, buys him a Corvette.

What we need here is very careful thinking of exactly what to do to rectify a very serious national problem. And that is what we are trying to do. I think we have seen a large number of groups and experts get involved in solving these problems of education that we have not been involved in traditionally.

I think we are developing some very, very powerful programs, right. And one of the reasons for that flat budget in the National Science Foundation is because we cannot spend all the 1984 funds, and we are seeing a substantial carryover.

But I assure you of one thing, and that is that the management attention in my office and in the National Science Foundation and elsewhere is grossly disproportionate. It is a problem that we are spending an enormous amount of time on. And I think you will see increases in a future—in future years. But they will be coupled with programs that I think you will very much enjoy hearing about.

Mr. GREGG. Well, good, that—I'm happy to hear that answer. I think it's excellent.

Another—another area entirely separate. I notice that you got NBS going into biotechnology, uh, and yet you are also taking it out of, it looks like fire research in your area where it is obviously very competent and it has no biotechnology background.

Why are you—and there you've got three or four other agencies going into biotechnology with enthusiasm—I think NSF and the Department of Agriculture. Why put NBS into this and take them out of fire research?

Dr. KEYWORTH. Because my feeling is that fire research is a State responsibility. Biotechnology is an embryonic area of science. In spite of the wonderful and incredible enthusiasm of intracapitalists into this promising technology, it is just barely at the embryonic stage. And if we are not extremely careful, we are going to lose the opportunity that we invented and developed in this country. And that is why we are trying to take steps to move the agricultural community, for example, to achieve the fruits of biotechnology.

That is why we are trying to get the National Bureau of Standards to pay attention to the required standards and information that is required as we broaden our biotechnology base. We have the potential here of—as you are certainly aware—an industry that could become hundreds of billions of dollars in the foreseeable future. And we need to broaden the impact of that; we need to broaden the areas of that participate in biotechnology research—a very different issue than fire research, in my opinion.

The CHAIRMAN. Thank you, Mr. Gregg.

Mr. Reid.

Mr. REID. Thank you, Mr. Chairman.

About half of all students in graduate programs are foreign students—43 percent, I think, is the figure. Now, is this indicative of the declining attractiveness of scientific programs for Americans?

Dr. KEYWORTH. Not at all, but it is indicative of a problem. First, it says that our universities—it does say that our universities are the world's best. And that's why so many foreign students are attracted to our schools. That's one statement.

Second statement, it says that we are not attracting enough of our top young talent into those professions, into those areas of study. Why? Largely economic problems, I think. I mean, economic incentives, as near as we can understand it. I think that is changing very rapidly. And I think there are some interesting distributional changes.

Mr. REID. Tell me how it's changing.

Dr. KEYWORTH. Engineers, for instance, are flocking to our schools—undergraduate engineers. And the number enrolled is increasing very rapidly. On the other hand, in some other areas such

as in social sciences, it is being reduced very rapidly. And that shows up in the whole science statistic. But, I'm not disagreeing that there is an important significance in that statistic.

We need to draw more American students, but those foreign students are major contributors to the excellence of American universities. We need them, too. What we need, in my opinion, is more opportunities in schools, more training opportunities, without compromising our level of excellence in any way. And I believe that can be done and it is, for example, why we have put so much emphasis on improving the academic quality of life to attract more and better young faculty.

Mr. REID. We have, in this committee, passed an emergency math and science bill to stimulate young people being interested in taking science and math courses. And we have also, of course, in this bill, done some things to make it more attractive for teachers to stay in the scientific fields—math fields. Do you feel that this is a proper role of the Federal Government ?

Dr. KEYWORTH. I feel that there is a proper role. I think——

Mr. REID. If this isn't the proper role, tell me what you feel would be.

Dr. KEYWORTH. I think that the Federal Government appropriately should support research in new technologies that improve the learning process. And that's rapidly changing because of, as we all know, because of advances in data processing. I feel that the Federal Government should and could be responsive in developing the means and tools by which we can upgrade the skills and quality of our teachers.

I feel that critical information that can pertain to, for example.——

Mr. REID. What good does it do——

Dr. KEYWORTH [continuing]. New curricula.

Mr. REID [continuing]. To increase the skills of the teachers when we don't have them to begin with?

Dr. KEYWORTH. The teachers that are presently there are excellent teachers. They are not vacuums. The fact is their skills can be drastically improved.

Mr. REID. But you see, that doesn't answer——

Dr. KEYWORTH. Most teachers——

Mr. REID [continuing]. The basic problem that I have, and that basic problem is we were given statistics here that we have less physics teachers than we have school districts, not schools. And so, I am sure it helps those people who are physics teachers. But what we are talking about here is creating new physics teachers.

Dr. KEYWORTH. Excuse me. I heard, I see your question better now.

Clearly, we need to attract more scientists and engineers into teaching. No question. Clearly, you can't do it when the economic disincentives are as strong as they are today. Clearly, we are going to need to pay a young scientist-teacher sufficient funds so that he has an opportunity to choose teaching as a career relative to research. We are not doing it.

The Federal Government, in my opinion, should have nothing to do with this. And I believe if we do so we will be stomping on one of the healthiest enterprises we do have, which is close public sup-

port for education: linking the parent to the support process directly. And I think in spite of what all of us do, what is happening out there in the heartland of America is vastly more significant than anything any of us can do here.

Mr. REID. But of course, the bill that we reported out of this committee did maintain the local system at—to set up a different—a number of incentives for scientists.

I think one of the things that is concerning to me is that the United States, among all the industrialized nations, has experienced slower growth rates and manufacturing productivity.

Now, do you think that has something to do with the fact that we are not maintaining our scientific base?

Dr. KEYWORTH. I think the lower productivity probably has two major components, and please let this be speculative. I have thought about this quite a bit. I think one of them certainly has to do with national mood malaise, morale, if you wish.

Another one has to do with the fact that we have not done a very good job of training the type of manufacturing engineers that the Japanese have done such an excellent job in training. And concomittant with that is the fact that we have unacceptable sociological barriers between those laboratories where the most productive research emanates and the users are industry.

Mr. REID. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. Reid.

Mr. MacKay.

Mr. MACKAY. Dr. Keyworth, I've been somewhat confused by an apparent disparity between your charts and some of the data in Science Indicators. The Science Indicator report seems to indicate that Defense is 64 percent of total Federal R&D. It seems to indicate that U.S. civilian R&D is at a lower percent of our gross national product than our international competitors. And it seems to indicate that support for academic research is less now than in 1981. I am not sure those figures are current. And it indicates that U.S. productivity is growing at a slower rate than our international competitors.

Now, I would like to ask a couple of questions. One, are these statements accurate? And, two, if so, what is your responsibility as the President's Science Adviser? It appears, based on these, that we are, in effect, dramatically increasing defense research and development. And despite your chart, it would appear to me that a great deal more is going into applied research than basic research; that we are suffering some side effects such as the decrease in the availability of information because of the Defense Department's real or imagined need to classify everything.

And what I'm saying is that it appears to me that you are presiding over a dramatic shift in policy which your report to us today doesn't seem to mention. I would like your comments. Is that true? And, if so, what is your responsibility?

Dr. KEYWORTH. That is a favored theme by certain elements of the press. But, that is not based in very much fact.

Mr. MACKAY. Well, Scientific Indicators, now——

Dr. KEYWORTH. Let me be——

Mr. MACKAY [continuing]. Is a Government report, not a press report.

Dr. KEYWORTH. Let me be specific and I think I can explain it to you because I get all the same numbers I have given you today come from Science Indicators.

The fact is when you talk about support for universities, for example, the latest data you can get from that Science Indicators is 1982. I was addressing the 4 years of the Reagan administration, 1982, 1983, 1984, and 1985. The fact is that in 1982, when you looked back it was correct—universities had been receiving diminished support over the previous 4 years.

In our administration they—they have gone up by more than 55 percent. And Science Indicator doesn't have that yet. But, un—but, fortunately, NSF has been able to acquire the data from the same data base parallel for us.

Yes, there's no question that the Defense component of Federal R&D has been growing very rapidly. And there's no question also that nondefense R&D has not been growing very much and, in fact, hardly at all.

What I have tried to emphasize here is the basic research component, which to me is and has long been the single really large leverage in Federal R&D expenditures on future economic growth. That is a complete turnover. We have made that from the smallest component to the largest component. And we have, if you wish, redirected the expenditures of civilian R&D.

There is absolutely no basis to push for increased Federal civilian R&D when we still have been throwing a considerable fraction of our resources down the tubes.

If you compare U.S. R&D expenditures with foreign countries and leave out DOD, then it is true, we don't look anywhere near as good as we do in the normal statistics. You can't do that. DOD's R&D investments are generally better targeted than most socialized countries' direct efforts at trying to drive their industry.

Mr. MACKAY. Then let me ask, if I might, another question, if there's time for this.

I've seen charts that indicate that our productivity decline is directly related to the almost inverse proportion of Federal R&D moneys, like the manufacturing sector. That the manufacturing sector—these are not current figures and I don't, as you say, I don't know what the current figures are. Perhaps that's also an area that's your responsibility. Like maybe 55 percent of our export market is in a sector that you would call manufacturing. And that's where we've been suffering huge losses. And that there is a correlation between that loss in productivity our loss in markets, and the failure to put research or perhaps development money in there to help keep our industries current, whereas, maybe 10 or 20 or 30 percent of our foreign markets are in areas like aircraft. But a huge percentage of our research and development money has gone in there and sure enough we've got more productivity—more productive and we are more competitive.

Do you see a responsibility to track that and to be an advocate that we put money, for instance, in research and development in steel, basic industries, and so forth? Or is it conceded that it's part of God's law that we are going to lose that and that the research expenditures have nothing to do with that?

Dr. KEYWORTH. If I may answer that quickly. First of all, I think the correlation—direct correlation between productivity and Federal R&D expenditures in any area is a very hard one to draw. And I think actually the only correlation has been because both—because high inflation occurred at a time of decreasing productivity.

Now, however, you hit a resonance with me, if you wish, because we have been spending an enormous amount of time in the last 6 months on looking at some of the troubled industries and working with corporate managers.

I believe that many of our troubled industries would benefit enormously from better access to the U.S. technology base and we are trying to do that with Federal laboratories, groups of corporate leaders, and universities. And I think allowing that to happen, or encouraging it to happen, rather, is extremely important. And I am unprepared to associate that with any dollars or any dollar amount at the moment. But I am saying is some of the mechanisms, and what I referred to earlier is sociological barriers in our society have handicapped us terribly and they don't exist in the younger Japanese industry and technology base.

Mr. MACKAY. Thank you. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. MacKay.

Mr. Walgren.

Mr. WALGREN. Thank you, Mr. Chairman.

Dr. Keyworth, you made a relatively absolute statement about fire research being a responsibility of the States, period. I'd like to, at least see if you—if you have any appreciation of the Federal responsibility in fire research and give you an opportunity to qualify that statement.

Dr. KEYWORTH. I really don't feel very inclined to qualify the statement. I'd be happy to let it stand as it is. What I guess I am trying to say is that we could, any of us could come up with a random sum, let's say $10 billion, to invest in research, and feel that it is a lot better way to spend money than a lot of other ways.

My point is that in looking at, trying to clearly define what is a Federal responsibility even in the case of basic research of Federal thrust, I see a very clear distinction between that and fire research. Every State in the Union spends a substantial amount of money on fire prevention and fire treatment.

Mr. WALGREN. Let me ask you whether you see any difference between fire prevention per se and some of the highly technical events that go on in fire with toxic acids and the like and whether or not we don't, as a national level, given the fact that the States are so completely occupied with necessary prevention efforts, don't we have an obligation to explore some of the basic fundamental fire problems?

Dr. KEYWORTH. I think we are. We are doing it in other areas of pure disciplinary research. For example, there is funded in the National Science Foundation, research in hydrodynamics and large computer simulation that applies very directly to the fundamentals of how fires build and propagate as is comparable research in the field of chemistry. The particular programs in the National Bureau of Standards, I feel strongly simply are programs that could readily be accommodated elsewhere in general or will be accommodated as

disciplinary endeavors in agencies that support disciplinary research.

Mr. WALGREN. All right.

Let me ask you—you indicated as far as the space station was concerned that the first justification that you mentioned for it was manufacturing and were very candid in saying that the science is not the reason for the space station.

Are we taking specific steps to be sure that we insulate the science budgets from the efforts that we make in pursuit of these other values when here is the fear that spending $8 billion, or thereabouts, over any period of time will distort what we know we need to accomplish in other scientific areas? Are we taking specific steps to insulate science budgets from that commitment?

Dr. KEYWORTH. Yes; we are. And let me say again that I am delighted to hear the concern and question on the part of the committee, as Mr. Brown asked me almost the same question. You will see in this budget clear, new thrusts in space sciences. You will see a new thrust to give special clarity to the field of solar terrestrial science; new missions in astronomy and astrophysics, and new missions in planetary science.

I believe we must continue, all of us, to keep primary emphasis on extracting from what we—the science from what we already know how to do. And that's what we are doing.

Mr. WALGREN. Yes.

Dr. KEYWORTH. But I think we've all learned a big lesson from the period of 1972 to 1982, and I hope none of us fall into the trap again. I don't know any way of legislating it, per se, that would work.

Mr. WALGREN. But there would be ways of managing it. It would seem that just the fact that we are doing other things also is not the kind of managing isolation, or the managing—it seems to me that would not fulfill the—a manager's responsibility that takes specific steps to be sure that funds are not siphoned away from other valuable scientific efforts. And I would hope the administration would be able to point to specific management steps to be sure that that's not a major concern.

Let me ask you, we are apparently contemplating withdrawing from, from UNESCO at the end of the year. Are we planning any specific steps there to continue, whatever valuable scientific international, cooperative efforts we are presently engaged in through UNESCO?

Dr. KEYWORTH. We have been, ourselves, as an office, taking a careful look at exactly what would be lost. And we are encouraged and, in fact, ensured by most of the participating agencies that the key work, particularly in the area of meteorology, will be easily and thoroughly continued and supported in the event that we withdraw from UNESCO in 1985.

Mr. WALGREN. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. Walgren.

Mr. Lewis.

Mr. LEWIS. Thank you, Mr. Chairman.

Dr. Keyworth, I would like to go back to the space station and ask if OSTP or yourself in any way have explored with friendly European nations the possibility of establishing a consortion, looking

to, or take advantage of their technical abilities as well as financing?

Dr. KEYWORTH. There has been considerable dialog with Europeans, Japanese, and others in participating, sharing the development of the space station. NASA in particular has been quite effective and quite aggressive in this. Until a firm decision was made to proceed with the space station at this time it was very difficult to jell those to make them more tangible and concrete. And I think you will see that happening in the rather near future.

Mr. LEWIS. One final question. The discussion earlier on the technical abilities and talents that were lacking now both in the areas of science and math, this committee passed a bill last March that has been resting in the Senate.

Has OSTP any urge to try to nudge that bill out of there and get it passed, or don't you favor the bill?

Dr. KEYWORTH. Well, that particular interest, first of all, I generally am not involved in the whole process of legislative affairs other than working with Members of Congress on issues of mutual concern where I think we are all deeply concerned about this problem—no question. The question is exactly how we go about it. And what we are doing is we are working, yes, with Members of Congress, and members of the teaching academic profession, and industry, in trying to see how we can best lever the problem with Federal funds. And I do not think that that bill alone solves the problem, by any means. And I think we need to do an awful lot more thinking before we spend an awful lot more money.

Mr. MCCURDY. Will the gentleman yield?

Mr. LEWIS. Well, let me just finish my time here.

Dr. Keyworth, don't you feel that this would be a first step, you have to crawl before you walk? This has not been done before and the influence of OSTP with the administration could help nudge that bill out of there, I would think.

Dr. KEYWORTH. As far as the first part of the question, I think—I don't—we have looked at the bill carefully, we have thought about it. I think some parts of it are good, some parts of it perhaps less so. Asking me whether I am going to support a particular bill that is up, I think is less important than asking us and expecting us to work together to try to haul this long problem.

Mr. LEWIS. I yield to the gentleman from Oklahoma.

Mr. MCCURDY. Well, the gentleman has raised a very good question and I am not sure Dr. Keyworth has responded, certainly not to the satisfaction of the bipartisan support we had for that bill. And we hate to see this thing sit in the Senate while people who should be involved and could be effective spokesmen on his behalf sit on their hands. We can do nothing for another 2 years, or we can do nothing for another 4 years if that is your prediction. And that will not assist those people who generally are interested and would like to receive some support.

In the State of Oklahoma, my State, we found that 50 percent of those people teaching math and science were not qualified. The State, this year, just last week voted a $150 million cut in its budget because of deficit problems; and they are crying for support in health.

I think I would ask the Doctor, Dr. Keyworth, please, if you are indeed serious about this, that we at least get some communication between the House, the relevant committees, and the Senate and the administration, because we are not talking about a $430 million bill when it comes out of conference. We are talking about at least a small step moving in the right direction.

Dr. KEYWORTH. OK. Let us see if I can be a little more specific. I think we clearly need to work together to get a good bill. I don't now recommend that bill. I don't think it is—its components are the right components. And I would like to work together on trying to make it that way.

What I am trying to say is that there is no one in this country, including a teacher society, an academic group, or any other, who has come up with any set of concrete proposals that really address the problem other than a clear-cut paying teachers decent salaries.

I think we are seeing some very, very excellent ideas emerge and we are trying to be very responsive to them. And I will go back to an analogy I made earlier about a parent who raises a child for 18 years and gives him a Corvette. And if I look at the effect I believe that bill will have relative to its cost, then I think we ought to go looking for a hundred billion dollars to really handle the problem.

Mr. LEWIS. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Bateman.

Mr. BATEMAN. Thank you, Mr. Chairman.

Dr. Keyworth, in the longer version of your statement today which I have had the opportunity to go through, I note that you call attention to the proposal for a continuous electron beam accelerator facility for investigation of the role of the Quarks, in the atomic nuclei.

Would you take a moment to tell us why you feel that this is an important scientific initiative and whether or not if a better understanding of the role of the Quark and the atomic nuclei is important? Do we require a facility in order to investigate?

Dr. KEYWORTH. Certainly, I relish the opportunity. Nuclear physics, which happens to be my, you know, profession, is going through an absolute renaissance. It had a very exciting 2- or 3-year decade prior to the late sixties and it has lain relatively dormant while we look carefully at where the trends and theory were leading us. We are now at an incredibly exciting point.

And I think there is great unanimity within the nuclear physics community and even external communities that the opportunities that are available with a large electron accelerator and also with a large heavy ion accelerator in parallel will open up a complete new field and allow us to achieve this illusive goal of so-called unified theory in which all the forces of nature can be treated in one self-consistent theory.

I was delighted at the first-class proposals that we have been able to receive over the last year or two. A very objective analysis was made, and a proposal was made and a decision was made to build this, albeit expensive facility, in the State of Virginia.

I think we will see immense fruits from it in future years, and I think it is one of the things that I can point to with greatest pride in our new initiative.

Mr. BATEMAN. I certainly commend the answer, and I think it was a very responsive one.

I take it that what has happened in the world of nuclear physics is that over a period of time the thinking of the physics community has jelled on what the initiatives need to be. And a great deal of focus has been given to what is necessary in order to go forward with a well-perceived course of action that there is virtual unanimity on.

I might inquire as to whether or not, given the Department of Energy's budgetary recommendations, if more can be well spent within fiscal year 1985. Would it serve the Nation's interest to expend additional money to, accelerate the construction of this accelerator?

Dr. KEYWORTH. To me the sooner we can get the accelerator doing its task, the better off, and in fact the cheaper it will be in the long run. I think the deliberations that we were motivated by in determining a budget level were strictly determined by the state of clear definition. We would like this one new group to proceed as rapidly as they can and we had even talked about opportunities for a later supplemental this year if warranted. Right now it needs some additional design work and that's why the sort of tentative nature of this funding stop.

The commitment, I assure you, is not tentative.

Mr. BATEMAN. Thank you, Doctor, very much, for your responses.

The CHAIRMAN. Thank you very much.

Mr. Walker.

Mr. WALKER. Thank you, Mr. Chairman.

First of all, as a card-carrying member of the National Council of Corvette Clubs, I must say to you that the purchase of a Corvette may not be as irresponsible as you think—a Porsche, perhaps. [Laughter.]

I understand included down in this budget somewhere is some money to carry forward the pork barrel that was put in on the House floor last year for Columbia University and Catholic University.

Can you confirm that, since that was—had absolutely no peer review, was stuck in in the last minute on the House floor? And I think that in light of the kinds of criteria that we usually judge scientific projects by, that it would be questionable for the administration to send that up as part of their budget. Is it in there?

Dr. KEYWORTH. I think it is in there and if it is, and my understanding is correct, it is there for entirely political reasons. I think I will offer my own personal opinion on this. I think that the greatest—one of the greatest threats to the health of American science is to permit the process of pork to completely bypass the judgments that have been difficult enough in the past but they have ensured our scientific capability.

I think it is magnificent that most of the academic and scientific community has gotten together and have almost universally criticized the process of using a local public relations firm, or whatever, to bypass the traditional process.

It is not just these two. The threat could be devastating and I think we have discussed this with many of you all.

Mr. WALKER. I thank you and I couldn't agree more.

Would you see a problem in light of your statements with regard to the need for commercialization and industrialization tied to the space station—which I think are right on target—would you see a problem from your perspective in the OSTP—would amending the Organic Space Act to include language that would assure that one of NASA's objectives was the promotion of space industrialization/ commercialization?

Dr. KEYWORTH. No.

Mr. WALKER. In the space station funding has any contem—is there any contemplation, or is there any provision for including in that some private funding of a—the effort, and also the international cooperation aspects; is there some thought being given to having, some of the foreign governments that agree to cooperate with this—put some money into the project?

Dr. KEYWORTH. And then if he specified in a particular, budget submission. But I assure you those are both thorough objectives as a President that he has transmitted to NASA, and they will most certainly be pursued.

Mr. WALKER. Thank you.

There is a saying among investors that so long as Government's involved, it is not serious business. That is, that no national investor would compete with the Government.

In view of that, what are your recommendations for the appropriate role of the Federal Government in space commercialization and manufacturing and space transportation, remote sensing, some of those kinds of things? In other words, where has Government become an impediment to investment rather than a facilitator of investment?

Dr. KEYWORTH. I hate to display a black and white bias, but I think Government presence is bad. And, of course, you should seek as rapidly as you possibly can to get it entirely into the private sector.

Here, however, we are faced with a specific problem. We don't have private sector deeply into any aspect of the space program. I believe we should take every effort necessary to get them in, in manufacturing, in expendable launch vehicle services, and so on. And then our objective should be to get them in as far as possible, and to free them as much from, from government partnership as it has—as we can. I think we can isolate areas as applications develop, and do that.

Mr. WALKER. And insofar as we set standards to begin with that allow a lot of private involvement in, for instance, space station design and, the uses of it, and also international cooperation upfront, it seems to me that you end up then encouraging that process to take place as those facilities to come on line. Is that——

Dr. KEYWORTH. Absolutely. We need the ingenuity, the marketing, and the intrinsic competition that will come from exactly that kind of involvement.

Mr. WALKER. And is it—is there the thought with regard to the space station of designing a station in such a way that it is rapidly expandable so that as you encourage, then, private investment, you have a space station that can be a habitat for people who are looking to be aggressive in following up on that initial development? Is that a part of the plan?

Dr. KEYWORTH. Precisely.

Mr. WALKER. Thank you, Mr. Chairman.

Dr. KEYWORTH. I was just informed that there is no—there are no funds in the DOE budget for 1985 for the two buildings that you mentioned. And I think the reason, as I now recollect, is because there are no proposals, because when the money was authorized, the universities involved were sufficiently stopped—they didn't have proposals, nor architectural designs. [Laughter]

Mr. WALKER. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Mr. Walker.

Mr. Nelson.

Mr. NELSON. Thank you, Mr. Chairman.

Dr. Keyworth, I'm delighted to hear of your support for the space station. Tell me, what turned your opinion around?

Dr. KEYWORTH. You know, I'm getting a little sensitive to this, but, I'm learning to control myself. For a long time, for 2 years, I asked time and time again, testified repeatedly, on the subject that I thought the space station needed better definition and more attention needed to be paid to the use of automation technology. I have said that consistently. And I still am concerned about the lack of clear definition of the space station at this time.

I, also, however, have been quite enthusiastic about taking the next bold step in space. And I believe that we should and must do it now. I believe that the mood of the Nation, the optimism, the importance of technology and future growth, and so on, is all so important, that I believe that we should proceed right now. And I am confident that the space station will become part of the next long-term, bold step for NASA.

In other words, my concern is that when I have looked at it it has always appeared too tenuous, no matter how I adjusted my glasses. And, second, I have always had great difficulty in seeing this space station as purely an end in itself because it is in large way—large measure a doorway.

Mr. NELSON. You say you were sensitive about it. You mean you are sensitive because people misrepresented your position?

Dr. KEYWORTH. I would say that my position on this traditionally has been cleverly manipulated on innumerable occasions.

Mr. NELSON. By whom?

Dr. KEYWORTH. I think we can, by those who could be served well by doing so. Certainly not by the Congress.

Mr. NELSON. Nor by the aerospace industry?

Dr. KEYWORTH. Nor by it.

Mr. NELSON. Well, I think that it is a remarkable compliment to the administration, that the administration would take this bold step, and I think that is a marvelous step. And I think the Nation is going to benefit as a result of it.

Now, can you share with me from your perspective as the Science Adviser what you see in this budget with regard to keeping alive the option for a fifth orbiter, so that as we develop the space station and we see that a fifth orbiter is needed that we don't have a tremendously expensive gearup cost at that point? What is here that you understand?

Dr. KEYWORTH. Well——

Mr. NELSON. I will, of course, ask that question of Jim Beggs when he is here, but I would like it from your perspective.

Dr. KEYWORTH. I, first of all, I think the space station in the budget opens a host of new questions, one of which is this.

Second, as you know, we have included funds now—introduced funds in 1984, to keep the line open, the construction, the assembly line open, through providing spares—that is still there. That opportunity will not remain open forever, however, nor would I say so.

I think as we proceed to provide clear definition for the space station—exactly what we are going to build, and exactly where we are going, I think the entire question of extended orbiter life, of relooking at the mission schedule, and how it is perturbed by the space station, may very well make us reopen the whole issue of a fifth orbit. No question.

Mr. NELSON. Do you think there's sufficient room in here to keep that option alive in the 1985 budget?

Dr. KEYWORTH. I think the option will remain alive as it stands. I think the question is that if you make the decision to do so with fiscal 1989 funds, you will find yourself essentially buying a new shuttle.

Mr. NELSON. At what point does the option expire under the present budget as projected out through the rest of the decade?

Dr. KEYWORTH. I would defer that question, if I may, to Jim Beggs. He is just better qualified than I to answer it.

Mr. NELSON. OK. Let me ask you about some of the policy with regard to the strategic petroleum oil reserve. This is the budget document and a chart that rather dramatically shows the drop off in the spending for SPRO. Can you give me some of your ideas as to the fact that it will be filled but at a moderate level as opposed to a more aggressive level?

Dr. KEYWORTH. I think there is inevitably a need—an urgency of need that changes with, let us say, the level in your well. In this case several things have changed. First of all, we have achieved a substantial capacity already. Second of all, our dependency upon suppliers has altered dramatically from Arab nations to primarily those of our own in the Americas. A very different situation.

I think the urgency is sufficiently reduced right now, that we can simply reduce the fill rate accordingly. It is a tremendous outlay of money.

Mr. NELSON. Thank you, Mr. Chairman. I wish I had some time to continue.

The CHAIRMAN. Thank you, Mr. Nelson. Mrs. Schneider?

Mrs. SCHNEIDER. Dr. Keyworth, recognizing we have so little time and I have narrowed down a multitude of my questions to only five, and I tried to shape them in such a way that I could get yes or no answers to make it easier on you, I thought I would begin with the question of acid rain, the R&D money that will be increased in the R&D budget. It has come to my attention that what is acid rain's gain is the loss of other R&D programs, and I wonder if you could elaborate.

Are dollars, in fact, being taken from other R&D programs in order to put them into an acid rain program?

Dr. KEYWORTH. I'm sure some are. I hope they are. I don't know exactly how many. I think the priorities in scientific research

always change. I think we see some real opportunity to make some breakthroughs in acid rain research and I think that should receive principle emphasis.

Mrs. SCHNEIDER. And are those dollars going to be going directly to one agency or to the acid rain task force?

Dr. KEYWORTH. I don't really know the answer to that, but I think they will be going to the EPA, of course. Although there is a small amount of money in the—$5 million in the Department of Energy that I was not aware of, also.

Mrs. SCHNEIDER. OK, well, there are moneys in NOAA. There are, indeed, dollars for acid rain spread throughout various Federal agencies and I wonder if you at some point could let me know what the increases might be, more for the task force or for EPA, or whatever.

Dr. KEYWORTH. Certainly. I'm well aware. The fact is there is a lot of supporting research that has been done for years in other agencies. The question of the newly targeted funds primarily for the purpose of, as you know, establishing the cost/benefit ratio, is primarily in EPA. Yes, I would be happy to do that.

Mrs. SCHNEIDER. OK. In the area of acid—excuse me, of hazardous waste, I think that we agree that certainly the marketplace should be where we can provide some incentives for appropriate disposal of our hazardous wastes and we have had witnesses come before this committee on various occasions indicating that we do have the technology available to deal with many of our wastes.

Are you supportive of the concept of providing tax incentives for the utilization of such technology in order to bridge what is often referred to as the technology transfer gap?

Dr. KEYWORTH. When justified.

Mrs. SCHNEIDER. And how would you determine in your own mind when that would be justified?

Dr. KEYWORTH. By having a clear scientific basis for understanding primarily the hazard that is involved, and I think the dioxine case, of course, has been a particular one that has displayed our inability to handle these issues on a scientifically supportable basis.

Mrs. SCHNEIDER. But primarily what I am referring to is not so much the cleanup, but the mitigation of future disasters like the dioxine disaster.

Dr. KEYWORTH. Again, it depends on the hazard and exactly how much the tax incentive would cost, relative to the benefit.

Mrs. SCHNEIDER. OK, thank you, and my colleague had been speaking earlier about some pork that was in this budget and needless to say, the seeds of eliminating a nice big piece of pork last year, the Clinch River breeder reactor, were sown right here in this committee, and one of my other colleagues mentioned earlier some of the recommendations by the Grace Commission, the Heritage Foundation, and the chairman was referring to the ERAB report.

The Synthetic Fuels Corporation is coming under continued attack. There are a number of pieces of legislation here to completely eliminate the Synthetic Fuels Corporation for various reasons, but primarily because it is a form of pork, as it has been currently analyzed.

What would be your attitude, as a scientist and in your current position, in terms of our disposing of the Synthetic Fuels Corporation?

Dr. KEYWORTH. Certainly scientifically, I don't think disposing of the Synthetic Fuels Corporation would have a very large impact on eventual opportunity or availability, are drawing upon the huge shale reserves and other synthetic fuel sources that we have.

Mrs. SCHNEIDER. And it does seem that if we are looking toward the private sector to assist us, in whether it be space programs or whatever programs, they certainly have not taken the initiative here and the opportunity that has been available, considering——

Dr. KEYWORTH. No, but it's interesting that the Federal Government did take the initiative in the 1970's and fell flat on its face, and private sector has stood back, looking at the economic incentives, and I'm sure they will continue to and they will leap in when the economic incentives are there.

Mrs. SCHNEIDER. Right.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you. Mr. McCurdy.

Mr. MCCURDY. Thank you, Mr. Chairman.

Dr. Keyworth, I would just follow up on a question we had earlier. I just would respectfully hope that we can enlist your support in trying to work out some compromise and hopefully achieve some progress on the math and science education bill.

As a member of the Armed Services Committee and also the Select Committee on Intelligence, in addition to this committee, I'm very much interested in where we're moving in the direction of ballistic missile defense technologies and you've become rather outspoken in that field.

The Washington Times, on January 26, has a large article—or an article, saying, "Barrier to Laser Beam—or Laser Weapons Broken," and citing your comments. Air Force Times, 31 October, Keyworth, "Base Defense Possible."

Could you just take a minute—and we are restricted on time—and just explain what OSTP's role is in development of the defense technologies and what effect you think this will have on other R&D functions. As a matter of fact, in one of the articles, it indicates that Keyworth said that—and I'm quoting—"that the research and development work would be supported with new funds, but some will also come from shifting funds out of existing R&D programs, even though he didn't say which programs would be tapped."

What direction are we moving here?

Dr. KEYWORTH. OK. My role—I have, as the President's science advisor, I have been intimately involved as, of course, the evolution of this experiment since the President's historic speech last March 23. I have worked, of course, closely with all the agencies and tried to keep the President as intimately informed as was possible and necessary.

Coming to the last point, where are the funds coming from; why did I make that comment? Because we have spent sufficient—we have spent a substantial sum of money, more than a billion dollars a year recently, on missile defense, technologies, and my point was that we wish to coordinate it into a broad program to meet the objectives that the President outlined in his speech.

That has not been the nature of that program in the past, as I have testified frequently. I think we can take money out of some of those programs to make a better coordinated program. It is not out of other R&D areas. And where are we going specifically? We will be perhaps submitting a proposal for a coordinated program with an overall increase of about $250 million and it will be allocated in a way that, let us say, resembles the Fletcher Committee's report, several different technologies must be pursued. There will be a priority—priorities will be identified. They will be far more clear—clearly delineated than in the Fletcher Committee's report.

Mr. MCCURDY. One report indicates it is not just $25 billion will be spent in this area in the current 5-year defense plan. Does the space station fit into this in any respect?

Dr. KEYWORTH. No, the space station has essentially no overlap with the strategic defense initiative, as near as our understanding of the technology can justify at the moment.

Mr. MCCURDY. Will there be military use of the space station?

Dr. KEYWORTH. Let's put it this way, neither I nor Mr. Casey nor Mr. Weinberger at this time have been able to see any clear and significant military role for the space station.

Mr. MCCURDY. I assume that OSTP is aware the 1972 ABM treaties and will be keeping an eye on that, also, with a look at developing missile defenses.

Dr. KEYWORTH. Since we are, of course, not even talking about deployment nor testing of a military system, we haven't had to spend a lot of time worrying about the 1972 treaties since R&D is completely allowed in it. I would simply say that I think the President here has focused his attentions and we have heavily, too, on the fact that in future years, we believe that Presidents are not going to have the tools to make decisions such as the strategic modernization decision unless we allow additional options, and this is one.

Mr. MCCURDY. Do you expect that the Department of Defense will want to fund any significant part of this growing research program through universities and, in your view, would the universities be willing to accept such funding, especially if certain or a number of restrictions on dissemination would be associated with that funding?

Dr. KEYWORTH. Well, I would hope so, because I think a key point here is drawing more talent into issues of national defense, as we once did. I hope the universities will be involved. I think DOD intends to and I don't think there will be the either opposition on the part of the universities in general at all, and I think where there are classification constraints, they will be clearly understood on both sides and not frequent.

Mr. MCCURDY. Thank you, Mr. Chairman, and again, I hope that perhaps some dialog—more dialog will be initiated between the different parties. Thank you.

The CHAIRMAN. Thank you, Mr. McCurdy.

Ms. Lloyd.

Mrs. LLOYD. Thank you very much, Mr. Chairman. I appreciate you being with us today, Dr. Keyworth.

I've been looking over the 1985 budget request for various DOE programs and I asked my staff to calculate the percentage changes

from the 1980—the last budget of the Carter administration—the 1981 budget to the levels that correspond in this year's budget and the results of this analysis are fossil is down 73 percent, solar is down 70 percent, geothermal is down 83, conservation R&D is down 73, and nuclear fission R&D, 54 percent, and electric energy programs, 68 percent.

Then our environmental and biological sciences down 28—19 percent and transportation 49 percent, but in this same period, Dr. Keyworth, I note that high-energy physics and nuclear physics and basic energy sciences have increased 36, 47, and 84 percent, respectively.

Now, on the other hand, I also understand that you have encouraged the high-energy physics community to think big and go after a super collider that would cost billions of dollars. Well, I don't understand how, Dr. Keyworth, how you can rationalize support for such massive increases in basic research. How can you explain this to the industrial and university people that have been so heavily involved in the energy development programs that this administration is really savage. As a matter of fact, if it were not for the Congress, these programs would be zeroed except for fission and fusion. I don't understand your thinking on this.

Dr. KEYWORTH. Mrs. Lloyd, I think that's a quite reasonable and generally accurate statement of the administration's science policy, and one which I am quite proud. I might also say that I have found that the majority of industry and academia thoroughly support the exact elements that you outlined.

The fact is that independent of whether we invest funds in renewable energy, the country is going to be seriously constrained by the quality of talent that we have, and that very expensive particle accelerator, for example, is a means by which we attract and train our best young people to go out and keep America strong.

Mrs. LLOYD. Dr. Keyworth, I don't mean this is not a very applaudable goal, but the point I was making, how can you do this to the exclusion of our energy research that we have been making some magnificant—such magnificant strides with——

Dr. KEYWORTH. Only glitter, no strides——

Mrs. LLOYD [continuing]. To all of a sudden have these cuts.

Dr. KEYWORTH. I beg to differ.

In the 1970's, with nearly $30 billion of expenditure, you hardly need two hands to count the number of barrels of oil that were displaced, or I might even add, likely to be displaced.

I think the money—most of the money that was spent on energy research, and I was then and am quite close to it now, was extremely ill-spent money with a very light—very, very poor return on investment and in turn, money on basic research has an enormous return.

Mrs. LLOYD. Aren't you basically a nuclear physicist?

Dr. KEYWORTH. I am basically a nuclear physicist, correct, who lived in a solar-heated home in northern New Mexico.

Mrs. LLOYD. Well, is your basic philosophy that we do not need further research in our fossil and in our——

Dr. KEYWORTH. I think there are some key areas of very important research, photovoltaics being one. I think a lot of the funds that we were using to do research in areas that were understood by

those who were living in the United States 2,000 years ago were uncalled for.

Mrs. LLOYD. Well, Dr. Keyworth, are you saying that we have taken the development—R&D development to the stage that the private sector can take over, or we don't need this research?

Dr. KEYWORTH. Both. The correct part, the justifiable part, the private sector can and will take over, but we increased funding so rapidly in energy in the 1970's, and we found ourselves afterwards doing a lot of research that we scientists felt was ludicrous.

Mrs. LLOYD. We have had overwhelming testimony on the subcommittee that I chair that—the opinion that we are not at the place where the private sector can take over and I would be happy to send you some copies of the testimony that my subcommittee has received for your consideration.

Dr. KEYWORTH. I am offering you my personal opinion. We can get people to testify on any side of any issue, like doctors in a courtroom.

Mrs. LLOYD. Well, you are not questioning the integrity of our witnesses, are you, Dr. Keyworth?

Dr. KEYWORTH. It depends. You have to show me the individual cases.

Mrs. LLOYD. Another area of concern to me, and you mentioned the Packard report in your statement, that feels like it really whitewashes the case against our national labs. If I may, Mr. Chairman, I ask unanimous consent that I may submit questions in writing to Dr. Keyworth.

Thank you very much.

The CHAIRMAN. Dr. Keyworth, we may have others that have questions. I think Mr. Winn has a question he wishes to submit and others for a written response.

I think you can see today by the participation a great deal of interest in our R&D and activities throughout our country and we thank you very much for being here today and responding very candidly to the questions and we look forward to working with you as the——

Dr. KEYWORTH. Thank you very much.

The CHAIRMAN [continuing]. Goes on.

Mr. Brown.

Mr. BROWN. For another 4 years, Dr. Keyworth. [Laughter.]

The CHAIRMAN. On that note, the committee stands adjourned.

[Whereupon, at 12:25 p.m., the committee was adjourned, to reconvene subject to the call of the Chair.]

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